Impacts of mining on the residential rental market in Ouro Preto, Brazil

Impactos da mineração no mercado de aluguéis residenciais em Ouro Preto, Brasil

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ABSTRACT

The impact of mining on residential rents is a significant concern in mining regions. This study examined the impact of negative externalities from mining companies Vale and Samarco on rental prices in Ouro Preto, Minas Gerais, in 2023. To achieve the proposed objective, a hedonic pricing model was estimated. The results showed that the closer a property is to mining activities, the lower its rental value, indicating a depreciation of real estate values. The conclusions suggest that mining externalities

affect the local real estate market, which is relevant for the creation of public policies that balance economic development and the mitigation of the negative impacts of mining.

Keywords: Real estate. Hedonic prices. Mining companies. Residential leasing.

RESUMO

O impacto da mineração nos aluguéis residenciais é uma questão importante em regiões mineradoras. Este estudo investigou como as externalidades negativas das mineradoras Vale e Samarco influenciam os preços dos aluguéis em Ouro Preto, Minas Gerais, em 2023. Para alcançar o objetivo proposto, foi estimado um modelo de precificação hedônica. Os resultados mostraram que quanto mais perto das atividades mineradoras, menor o valor dos aluguéis, evidenciando uma desvalorização dos imóveis. As conclusões sugerem que as externalidades da mineração afetam o mercado imobiliário local, o que é relevante para a criação de políticas públicas que equilibrem o desenvolvimento econômico e a mitigação dos impactos negativos da mineração.

Palavras-chaves: Setor imobiliário. Preços hedônicos. Mineradoras. Locação residencial.

1 INTRODUCTION

Mineral extraction drives economic growth in the municipalities where it is present, as it generates income, employment, and tax and royalty collections. However, the exercise of this activity has the potential to produce negative externalities on the environment and the health of the inhabitants (Kolala; Polyakov; Fogarty, 2020). Among the negative impacts generated, water, soil and atmospheric pollution stand out, as well as the reduction in the quality of life of the population living in the surrounding areas (Bai *et al.*, 2022). These unfavourable conditions make areas close to mining activity less attractive to live in, which can reduce the demand for real estate in the region. Consequently, the devaluation of real estate in the surroundings of mining areas becomes a reality because of the environmental and social adversities generated.

In addition to the problems mentioned, there is also an increase in the number of serious environmental disasters involving the mining sector in Brazil (Silva; Silva; Almeida, 2023). In view of this, the local population lives with the risk of tailings dams breaking. According to information from the National Mining Agency (ANM) (2024), there are 88 dams in Brazil with some level of alert or declared emergency. Of these, 48 are located in the Brazilian state of Minas Gerais, with the municipality of Ouro Preto leading the ranking, with the largest number of tailings dams at risk in the state[1].

In addition to being an important mining hub, Ouro Preto is a historic city recognised as a Unesco World Heritage Site[2], famous for its colonial architecture, which attracts tourists from all over the world. It is also home to the Federal University of Ouro Preto (Ufop), attracting a significant student population. This combination of mining, tourism and academic activity directly influences the local real estate market. On the other hand, the real estate supply and its expansion face restrictions of various natures, which prevent the real estate demand from being met satisfactorily[3].

At the same time, the importance of the real estate sector for the economic growth and development of a region is also highlighted. Silva and Santana (2020), for example, emphasise that housing assets are an indicator of the economic activity of a nation because they are essential to quality of life and require large amounts of financial resources. This fact highlights the importance of studies that examine the attributes that influence the variability of residential values across different geographic contexts, whether intrinsic to real estate assets, such as their physical characteristics, or extrinsic, including urban amenities and/or (dis)amenities.

In light of the above, some studies have sought to investigate the effects of mining activity on the surrounding area and how it can influence the pricing of residential properties. Cordera *et al.* (2019), for example, studied the influence of negative externalities from the steel industry on real estate prices in the province of Taranto, Italy. Using a hedonic pricing model, the authors found that distance from the factory was a largely positive factor in determining real estate prices. In addition, they observed that some of the pollution indicators had a negative effect on these prices.

Riveira (2020) explored the impact of the opening of new mineral extraction mines in Chile on the rental prices of nearby homes. In this study, the author observed that the opening of new mines led to a decrease in the rental prices of nearby homes. In other words, the social, environmental, and health degradation resulting from mining creates an unattractive environment for housing, which can result in a decrease in the value of properties located in places close to the extractive area.

Similarly, the study by Kolala, Polyakov, and Fogarty (2020) analysed the impacts of mining on property values in the city of Kalgoorlie-Boulder, Australia. Specifically, the authors tested whether proximity to an open-pit gold mine led to a devaluation of residential properties sold in the Kalgoorlie-Boulder metropolitan area. To do so, they employed a hedonic pricing model, with distance from the mine serving as the measure of impact. The results revealed that residential properties located two kilometers from the mine are sold at a discount of 20% to 30% compared to residential properties with similar characteristics located at least six or seven kilometers from this mine.

In general, as stressed out by Totanji and Ishaki (2023), although the literature on this topic is extensive, there is still no comprehensive list of factors that affect residential property prices. Therefore, efforts dedicated to studying the aspects that can influence real estate pricing are appropriate for understanding the target market.

Considering the relevance of mining activity for economies, the externalities generated, its potential locational impacts on the surroundings and the predominance of companies in this sector in the municipality of Ouro Preto, in the state of Minas Gerais, Brazil, this study seeks to answer the following question: Do the negative externalities generated by the presence of the mining companies Vale and Samarco affect the value of residential rents in Ouro Preto in 2023?

The central hypothesis of this study is that the proximity of mining areas in Ouro Preto devalues the value of rentals due to the negative externalities associated with mining activities, such as environmental risks, pollution, and geological instability. This relationship can be observed in light of the theory of negative externalities, which suggests that economic activities can impose costs on third parties without adequate compensation, and the hedonic pricing model, which explains how environmental and locational characteristics influence the value of properties.

There is a vast literature on the application of hedonic pricing models in the real estate market. According to Li *et al.* (2019), determining the factors that influence real estate values in developed and emerging countries is the subject of several empirical studies. However, although the impacts of economic activities on the housing market are significant, research covering this topic is still scarce (Akinsomi; Bangura; Yacim, 2024).

Thus, this study seeks to contribute to the literature by investigating how mining activity in Ouro Preto affects rental property prices. This analysis is important for developing policies that reconcile the preservation of Ouro Preto's historical and cultural value with the need to mitigate the adverse effects of mining on the population's quality of life and the local real estate market.

2 HEDONIC PRICING IN THE CONTEXT OF REAL ESTATE MARKETS

The housing sector is highly relevant to the economy because of its ability to generate jobs and income and encompass a variety of productive sectors (Paz; Nobre; Nobre, 2020). The real estate market stands out as one of the most peculiar subjects of study, owing to the importance that real estate holds for families. In addition to satisfying the need for shelter, it is a significant investment in the family's consumption basket. In addition, real estate is an asset with unusual characteristics, as its construction time is lengthy, its costs are high, and it is spatially rigid (Sant'Ana Júnior, 2006).

Furthermore, real estate is a heterogeneous asset, as it varies in size, style, age, location, and internal characteristics. Therefore, the physical environment, socioeconomic, and cultural aspects will also differ. According to Sedaghati *et al.* (2022), not all of its qualities are assessed by the supply and demand process; therefore, it is necessary to employ methods to measure the non-market benefits of housing. According to Paixão and Luporini (2019), real estate belongs to the class of "differentiated assets" characterised in this way, as each unit/model differs from the others due to the composition of its attributes. Thus, the literature on price indexes sought to find a way to measure price variation that would control the different compositions of these attributes.

According to Silva and Anastácio (2022), hedonic pricing models have been widely used to analyse the attributes that determine the variability in real estate values (Silva; Anastácio, 2022). Cui *et al.* (2018) note that this model enables the establishment of a relationship between rental prices and their characteristics, thereby serving as a tool to determine the dynamics of these prices.

The literature covering the applications of hedonic models for determining real estate values in both international and national literature is extensive. The application of the hedonic pricing model in the real estate market became popularly known as the Court-Griliches-Lancaster approach (Paixão, 2015). However, Court's work (1939) represents the seminal contribution that gave rise to hedonic regressions.

Lancaster (1966) and Rosen (1974) made significant theoretical contributions to the hedonic pricing model. The former emphasised that the greater the utility that the customer extracts from the property's attributes, the greater his willingness to pay for it, thus demonstrating the relationship between the product and its characteristics. Rosen (1974) was the first to structure, theoretically and empirically, the hedonic pricing model, based on product differentiation or implicit prices. The approaches of these authors emphasised the importance of attributes in defining the value of the real estate market price. The model is relevant because it captures the intensity with which firms and the average consumer value each characteristic of a good. Empirical applications to residential markets seek to determine, based on an explicit hedonic function, which attributes or bundles of these are most relevant to the composition of residential prices. According to Campos (2018), this method is based on the idea that properties are heterogeneous (Rosen, 1974) and that the utility of families responds to the intrinsic and extrinsic characteristics of the properties.

Therefore, the usefulness of the model derives from its ability to determine how the price of a unit of a good varies according to the attributes it possesses. Thus, if the prices of the attributes are known or can be estimated and the composition of attributes of a differentiated good is also known, the hedonic pricing methodology will provide a framework for estimating value (Ustaoÿlu, 2003). However, Ceccato (2017) emphasises that measuring the influence of an amenity on the price of real estate is not a simple task. According to John and Porsse (2016), the price of a property is determined by a set of independent variables (attributes), which behave according to their respective coefficients.

Campos (2017) emphasises that analyses involving real estate markets must consider not only their intrinsic characteristics, but also those surrounding the property. Therefore, the formation of real estate prices encompasses, in addition to their production costs, externalities, with location being a relevant attribute for determining their pricing. For the author, this variable serves as the connection

point between the areas of study of real estate markets, urban economics, and economic theory. According to Liang *et al.* (2018), proximity to neighbourhood services increases the value of properties by providing amenities and creating potential in terms of social, environmental and economic values.

According to Furtado (2009), agents choose properties not only for the issue of shelter, but also for the supply of goods and services in the neighbourhood. Thus, the characteristics of the surroundings, as well as the perception that economic agents have of the geographic space, form the identity of a district, city or state. For Silva and Santana (2020), in urban areas, geographic location is decisive for the provision of amenities (and/or disamenities), being one of the various inputs consumed by owners of residential properties.

Since Rosen (1974) extended the hedonic price theory to the real estate market, residential hedonic analysis has been widely applied as a tool for evaluating this market and for urban analysis. For this reason, in recent decades, the hedonic regression approach has been used in applications for the real estate market to investigate the relationship between residential property prices and their housing characteristics. There are three motivations for using this model in applications of this nature: (i) to construct price indexes; (ii) to estimate the value of properties, based on their characteristics, in general; (iii) to determine the impact of certain characteristics on the final price of the property, such as urban amenities[4] (Ciarlini; Ramos; Ferreira, 2022).

Hedonic modeling is an empirical analysis technique widely used to review the real estate market and identify the main determinants of property prices (Vergara-Perucich, 2023). Therefore, it allows estimating how and to what extent the set of attributes impacts the value of properties. In this article, as in the study by Ciarlini, Ramos and Ferreira (2022), data on residential rentals were used. As these authors emphasised, there are few studies in the national literature that use data on the rental market, possibly due to limitations in accessing a public database with information of this nature. Therefore, conducting studies focusing on residential rental markets constitutes a contribution to the literature in the area.

3 METHODOLOGY

According to Lu, Shi, and Pettit (2023), the hedonic price model analyses, based on the estimation of multiple regressions, the impact of structural, locational, and neighbourhood attributes on the final price of properties. The authors emphasise that the model is a classic approach widely used in research related to the real estate market.

In view of the above, the model chosen to achieve the objective proposed in this article was selected due to its relevance and widespread use in research of this nature, as documented in both national and international literature. In addition to the seminal contributions of Court (1939), Lancaster (1966) and Rosen (1974), the empirical applications of Hussain *et al.* (2021); Kolala, Forgaty, Li *et al.* (2019); Liang *et al.* (2018); Paz, Nobre, and Nobre (2020); Polyakov (2020); Vergara-Perucich (2023), among others, are cited.

3.1 HEDONIC SPECIFICATION

As mentioned, to achieve the proposed objective, a hedonic price model was estimated using multiple linear regression. Besides the variables of interest, the distance of the property from the Vale mining company and the Samarco mining company, other traditional variables used in hedonic pricing models were considered. These refer to the intrinsic attributes of the property, namely, the number of bedrooms and bathrooms, the presence of parking spaces and the ventilation conditions of the property. The distances of each property from the main square in the city, Praça Tiradentes, and from a

natural and recreational area in the city, the Itacolomi State Park, were also added to the model. Below, equation (1) represents the estimation conducted for the city of Ouro Preto in 2023:

$$lnRent_i = \beta_0 + \beta_1 lnDVale_i + \beta_2 lnDSamarco_i + \beta_3 lnNBed_i + \beta_4 lnNBath_i +$$
$$\beta_5 Parking_i + \beta_6 lnVent_i + \beta_7 lnDTiradentes_i + \beta_8 lnDItacolomi + \varepsilon_i \qquad (1)$$

where:

$lnRent_i$ = Logarithm of the rental value of property *i* (R$)

$lnDVale_i$ = Logarithm of the distance of property *i* in relation to the mining company Vale (km)

$lnDSamarco_i$ = Logarithm of the distance of property *i* in relation to the mining company Samarco (km)

$lnNBed_i$ = Logarithm of the number of bedrooms in property *i*

$lnNBath_i$ = Logarithm of the number of bathrooms in property *i*

$Parking_i$ = *dummy* presence of parking space[5] in property *i* (parking space = 1)

$lnVent_i$ = Logarithm of the ventilation condition of property *i* (1 = poor, 2 = satisfactory, 3 = good, 4 = excellent)

$lnDTiradentes_i$ = Logarithm of the distance of property *i* in relation to Praça Tiradentes (km)

$lnDItacolomi_i$ = Logarithm of the distance of property *i* in relation to Itacolomi State Park (km)

ε_i = error term

Regarding the variables of interest in equation (1), the distance, in kilometers, of property *i* in relation to the Vale mining company and the distance, in kilometers, of property *i* in relation to the Samarco mining company were considered. Properties located near these companies are expected to have relatively lower prices. That is, as the distance between a given property *i* and the mining companies increases, rental prices are expected to be higher. Regarding the intrinsic characteristics of properties, these are expected to be positively correlated with rental prices. In other words, properties with more bedrooms, bathrooms, parking spaces and airier environments should have relatively higher rental prices in the city of Ouro Preto, Minas Gerais.

The choice of Praça Tiradentes as a proxy for the distance of property *i* from amenities is justified by its central location in the historic region of the city, with the presence of museums, shops, restaurants, bars and cafés with historical and tourist infrastructure. This variable can, for example, exert positive pressure on rental prices, because in the context in which there is availability of properties for rent in this region, applicants may be willing to pay higher rents for the convenience of living near these amenities. Furthermore, Itacolomi State Park was chosen as a proxy for the distance of property *i* from amenities because of its extensive protected green area of conservation and natural attractions. The park also features the Museu do Chá and Casa Bandeirista, a historic building now a museum open to tourists[6], which once operated as a tile and brick production center, an iron factory, and later, a tea producer. There is a consensus in the literature on hedonic prices that the proximity of a property to green areas tends to increase its real estate value.

In this study, the hedonic pricing model, equation (1), was estimated using ordinary least squares (OLS), using STATA 12.0.

3.2 STUDY AREA, DATA, AND VARIABLES

In this study, hedonic price analysis was applied to the market of residential properties available for rent in the city of Ouro Preto in 2023. The municipality is located in the central region of Minas Gerais, at the southeastern end of the Iron Quadrangle, the state's mining-metallurgical zone.

In 2022, the estimated population of the city of Ouro Preto was 74,821 inhabitants, with a population density of 60.06 inhabitants per square kilometer (Brazilian Institute of Geography and Statistics – IBGE, 2023). According to IBGE (2023), in that same year, there were 37,581 households in the city, of which 94.2% were houses and 5.55% were apartments. Therefore, the residential real estate supply is predominantly composed of houses, most of which are historic buildings. Possibly, the restrictions imposed by the National Institute of Historical and Artistic Heritage (Iphan), a federal agency linked to the Ministry of Culture that is responsible for the preservation of Brazilian Cultural Heritage, may explain the low relative proportion of apartments built in this city.

In this article, data were used that make up a sample of 93 properties available for rent (houses and apartments), in the formal market, registered with real estate agencies in Ouro Preto in 2023.

The variables of interest were collected using Google Maps, which obtained the distance, in kilometers, between property *i* and the Vale and Samarco mining companies. Regarding the intrinsic variables of the properties, information on the rental value, number of bedrooms, number of bathrooms and number of parking spaces was collected from the websites of 11 real estate agencies operating in the city of Ouro Preto. The variable was constructed based on the ratio between the number of windows and the number of rooms in the property. The results of the calculated index that presented values close to 0.25 received a score of 1 and a poor rating; values close to 0.50, a score of 2 and a satisfactory rating; results close to 0.75 and 1, received scores of 3 and 4, and were classified as good and excellent, respectively. Finally, the distances of property i in relation to Praça Tiradentes and Itacolomi State Park were obtained using Google Maps, as were the variables of interest.

Figure 1 shows the spatial distribution of residential properties available for rent in the sample, categorised by rental value ranges, in relation to the mines of Vale and Samarco.
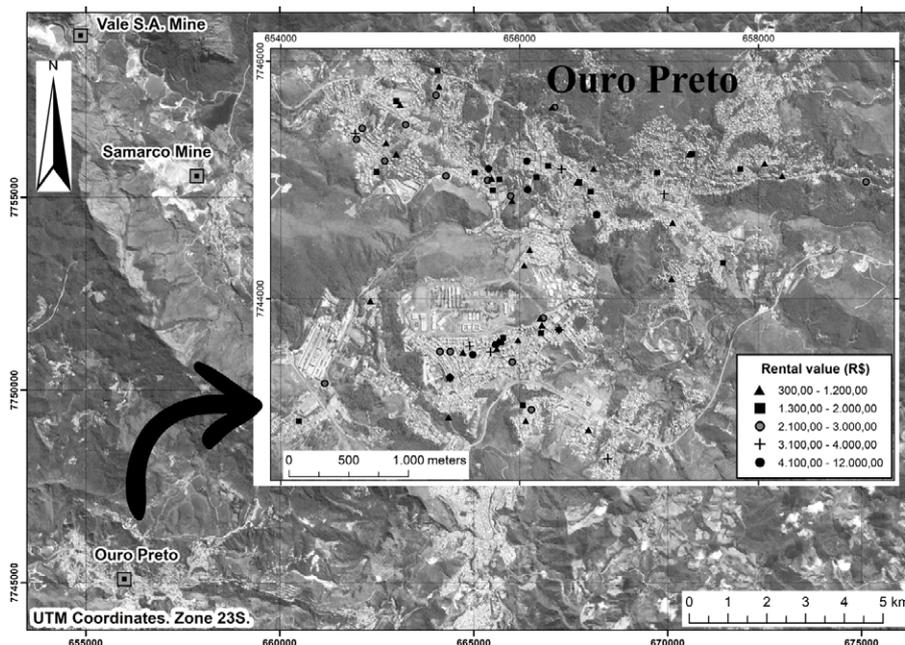

Figure 1 – Location of residential properties in the sample in relation to Vale and Samarco mines

Source: Own elaboration.

Based on the spatial dispersion of properties by price range, it can be seen that, in general, there are properties with higher rents located near properties with lower price ranges. Furthermore, there is no clear concentration of a specific price range in any region. Both properties with lower rents, between R$ 300 and R$ 1,200, and those with higher prices, ranging from R$ 4,100 to R$ 12,000, are distributed relatively evenly throughout the municipal territory.

Possibly, the lack of standardisation in the construction of properties, such as size, infrastructure, and finishing, a common phenomenon in cities with significant historical heritage, may partly explain this reality. Ouro Preto is a historic and touristic city, with a large number of old and preserved properties, which can have a high market value. These properties may be located in different parts of the city, not necessarily in a single central area, which contributes to the dispersion of rental values. The proximity of tourist attractions, such as historic churches and museums, can increase the value of certain units, even in areas that are not typically considered noble or central.

Similarly, the presence of students and mining workers generates a constant flow of people and creates a heterogeneous demand for housing, with varying needs and budgets. This demand can drive the emergence of properties with different values near the university campus and mining companies, but it can also influence the emergence of higher-value properties in areas that offer more amenities or proximity to services and leisure areas.

Another factor is the rugged topography of the city, which can impact property values depending on accessibility and proximity to flat areas that make it easier to get around. Even within the same neighbourhood, these topographical variations can result in large differences in rental values.

Finally, local infrastructure and the quality of services (such as public transportation, schools, and shops) also vary significantly from one area to another within the city. Hence, it is possible that the combination of these factors – historical-cultural, academic, extractive, topographic, and infrastructural – may, to some extent, contribute to the lack of a clear spatial standardisation in property values, resulting in a geographically dispersed distribution of the different rental ranges.

Table 1 below summarises the main information on the variables used in this study and presented in equation (1).

Table 1 – Variables considered in the study

Variable	Regressor	Description	Expected association
Dependent	$lnRent_i$	Property rental value *i* (R$)	-
Interest	$lnDVale_i$	Distance between property *i* and Vale (km)	Positive
	$lnDSamarco_i$	Distance between property *i* and Samarco (km)	Positive
Intrinsic	$lnNBed_i$	Number of bedrooms in property *i*	Positive
	$lnNBath_i$	Number of bathrooms in property *i*	Positive
	$Parking_i$	Parking space = 1	Positive
	$lnVent_i$	Ventilation of property *i* (1 = poor, 2 = satisfactory, 3 = good, 4 = excellent)	Positive
Amenities	$lnDTiradentes_i$	Distance between property *i* and Praça Tiradentes (km)	Negative
	$lnDItacolomi_i$	Distance between property *i* and Itacolomi State Park (km)	Negative

Source: Own elaboration.

4 RESULTS AND DISCUSSION

This section presents the results of the coefficients estimated from equation (1). Also, this study analyses whether the value of residential rents in the city of Ouro Preto is influenced by the distance of the property with respect to the Vale and Samarco mining companies, as well as by the attributes and amenities of the sampled real estate units. Table 2 presents the results obtained from estimating the hedonic equation.

Table 2 – Results of the estimated hedonic equation for the city of Ouro Preto, Minas Gerais

Variable	Regressor	Coefficient	Standard error
Constant	β_0	-4.615***	(1.479)
Interest	$lnDVale_i$	2.115**	(0.831)
	$lnDSamarco_i$	2.585**	(1.104)
Intrinsic	$lnNBed_i$	0.667***	(0.095)
	$lnNBath_i$	0.477***	(0.142)
	$Parking_i$	0.065*	(0.040)
	$lnVent_i$	0.224*	(0.132)
Amenities	$lnDTiradentes_i$	-0.272***	(0.064)
	$lnDItacolomi_i$	-0.133**	(0.067)
Adjusted R²		0.7867	
R²		0.7664	
F stat		38.72	
Prob. (F stat)		0.000	
Observations		93	
VIF test		1.80	
Prob. (Breusch-Pagan)		0.8384	
Prob. (White)		0.5196	

Notes: Estimated coefficient values were rounded to three decimal places. ***, ** and * indicate 1%, 5% and 10% statistical significance, respectively.

Source: Research results.

The model fit statistics, located at the bottom of Table 2, assess the quality and adequacy of the estimated regression. The adjusted R², for example, shows the extent to which the variation in residential rental prices in Ouro Preto is explained by the regressors, considering the number of independent variables included. In contrast, the simple R² indicates the proportion of the variation in the dependent variable explained by the regressors, without adjustment for the number of predictors. Overall, more than 78% of the variability in residential rental values in the city is explained by the attributes included in the model. Additionally, the F statistic and its associated probability indicate the overall significance of the model, pointing to the rejection of the null hypothesis that the estimated coefficients are statistically jointly equal to zero.

In this article, the main objective was to investigate whether the value of residential rentals in the city of Ouro Preto is affected by the distance of the property from the mining companies Vale and Samarco. When evaluating the estimated coefficient for the variable *Rent_i*, it was observed that there is a positive and statistically significant association between the location of Vale and the sampled properties. A similar result was found for the estimated coefficient for the variable *DSamarco_i*. Therefore, the greater the distance between the residential properties available for rent in Ouro Preto and these mining

companies, the higher the rental values will be. Possibly, the negative externalities generated by the extractive activity may reduce the attractiveness of the area, negatively impacting the well-being of residents who demand properties to meet their housing needs.

These results confirm the hypothesis raised in this study, suggesting that the negative externalities generated by mining activities may produce a devaluation in the rental value of properties located near these companies. As expected, this result is consistent with those found in the studies of Kolala, Polyakov and Fogarty (2020) and Riveira (2020). Although the mining activity boosts the economy and raises real estate values in the cities where it is present, the results of this study show that the negative externalities generated cause properties located in its surroundings to have lower rental values.

Regarding the regressors that capture intrinsic characteristics of real estate assets, the estimated coefficients reveal that the number of bedrooms and bathrooms, the presence of a parking space in the property, and the ventilation conditions of the housing unit were positive and statistically different from zero. In practical terms, a greater number of bedrooms and bathrooms, as well as properties with a parking space and better ventilation, demonstrate, on average, a relatively higher rental value. Additionally, the results in Table 2 show that the real estate pricing of houses and apartments for rent in Ouro Preto is, on average, relatively more sensitive to percentage increases in the number of bedrooms (0.66% increase in the rental value) than in the number of bathrooms (0.47%), for example.

Still regarding the results associated with the intrinsic features of the properties, the presence of a parking space in the property increases, on average, the rental value by approximately 0.07%. The estimated parameter for the variable $Vent_i$ revealed that as one moves from the lowest score, equivalent to poor ventilation, towards properties with better ventilation, i.e., a higher score, the residential rental value in the city of Ouro Preto increases, on average, by 0.22%. The relevance of this result is particularly noteworthy for the municipality of Ouro Preto, because of the specific climatic conditions of the region. Due to the high humidity and generally colder climate of the city, ventilation conditions become a decisive factor in the choice of real estate and, consequently, in the price of the properties located there. Additionally, the historical pattern of construction in the city often results in old properties with a reduced number of windows, a factor that contributes to potentially uncomfortable living environments.

Regarding the estimates of the variables representing the intrinsic attributes, the results found in this article were similar to those observed in recent literature on this topic. Examples include the studies of Ciarlini, Ramos, and Ferreira (2022); Fernandes *et al.* (2021); Freitas, and Cirino (2020); Freitas *et al.* (2024); Lu, Shi, and Pettit (2023); Paz, Nobre, and Nobre (2020).

The estimates of the coefficients of the attributes that represent proxies for the amenities, namely, distance from the property with respect to Praça Tiradentes and distance from the property with respect to Itacolomi State Park, were negative and statistically significant. This result shows that the shorter the distance from the property in relation to Praça Tiradentes and in relation to Parque do Itacolomi, the higher the rental value.

As mentioned, Praça Tiradentes is located in the central region of Ouro Preto, with the presence of museums, shops, restaurants, bars, and cafés with historic infrastructures. This adds value to the properties located in its surroundings. According to Hussain *et al.* (2021), the value of a property can be increased because of the presence of desirable amenities that make daily life more convenient and enjoyable for residents. In addition, Praça Tiradentes is a tourist attraction and, according to Campos and Almeida (2018), when properties are located in a neighbourhood with a high supply of cultural activities, their average price increases.

On the other hand, the proximity of the property to parks and green areas also contributes to its appreciation, which may partly justify the result obtained for the variable distance of the property from

Itacolomi State Park. Liu *et al.* (2024) argue that the existence of green amenities around a property can be considered a component of the total value of the property. Ben *et al.* (2023) add that residential properties with greater accessibility to green areas are more valued. In other words, the presence of public green spaces and natural parks significantly impacts the value of residential properties.

In general, the results found by estimating the hedonic price model, based on the sample used, were consistent with the local reality, explaining, to a large extent, the dynamics of the rental real estate market of Ouro Preto.

5 FINAL REMARKS

Different factors can influence the prices of properties available for rent in a given region. This study investigated the influence of the location of two mining companies, Vale and Samarco, on the values of residential rentals in Ouro Preto in 2023. At the same time, considering the tourist, university and historical profile of the city, the intrinsic and extrinsic characteristics of the sampled real estate properties were also analysed, in order to better understand the real estate market in the municipality of Ouro Preto.

The hypothesis raised in this study was that mineral extraction activity generates negative externalities that devalue the rental value of properties closest to the mines. The results found corroborated the initial assumption. This result was consistent with those found in studies with a similar objective to this article in the international literature. On the other hand, the estimates obtained for the variables that represent the intrinsic attributes of the properties and the urban amenities reflected the local reality and were also in line with the results of other articles in the literature in the area of urban economics.

It is important to note that studies of this nature, especially those conducted in smaller municipalities where the informal real estate market is present, may face limitations related to data availability. Therefore, it is essential to emphasise that the effort made in this study reflects the real estate scenario for residential rentals in the city of Ouro Preto based on an assessment of its formal market, through real estate agencies operating in the municipality. However, these agencies disclose limited information about real estate units, and the results provided in this study do not cover the rentals of houses and apartments negotiated informally.

In short, the results of this article have interesting practical implications. First, they elucidate that the undesirable effects resulting from extractive activities in Ouro Preto generate negative pressure on the value of properties located in the vicinity of mining companies. This knowledge can help investors in the real estate sector and those seeking rental housing not only in Ouro Preto, but also in regions that are influenced by mining companies. Likewise, the study reinforces the importance of measures to mitigate negative externalities arising from mining, which can affect both the environment and the real estate sector.

Finally, future research aimed at evaluating similar contexts may also encounter limitations in real estate data. Nonetheless, if the object of interest offers a broader set of information about the attributes specific to the sample and its surroundings, this can be incorporated into the analysis to enhance the ability to predict the variability in the rental values under consideration.

NOTES

1 | This information refers to the month of April 2024.

2 | Due to its heritage status recognised by Iphan, the city faces several restrictions on both vertical and horizontal expansion. These include building height limits, requirements for architectural harmony with the surroundings, land use restrictions, and regulations on renovations and demolitions, all aimed at preserving its cultural heritage (Brasil, 2010).

3 | In addition to heritage concerns, the characteristics of the soil, including areas classified as high-risk for construction, as well as environmental conservation zones such as the Itacolomi State Park and the Mata do Seminário, an environmental protection area (APA), also restrict the expansion of buildings (Fernandes, Fraga, and Fonseca, 2020).

4 | Urban amenities can be defined as a set of specific features of a location that contribute, either positively or negatively, to individual well-being. Amenities are not limited to natural features, such as green spaces, beaches, climate, and so on. The definition also includes man-made goods (or bads), such as traffic, pollution, availability of entertainment, safety, among others (Bartik *et al.*, 1987).

5 | A dummy variable was used for parking space, as a characteristic of this real estate market is the absence of parking spaces in historically built properties.

6 | As highlighted by Liu *et al.* (2024), the fact that urban green amenities are mostly open, free of charge, to visitors restricts the definition of a market price as a monetary measure. Thus, hedonic pricing is considered one of the tested and reliable methods for the monetary valuation of urban green amenities.

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