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## MILANO 1863

# The Impact of Remote Work on São Paulo's Real Estate Market: Spatial Regression Analysis of Price Dynamics

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# Although studies on the impact of remote work on the real estate market exist in North America and other regions, there is still a gap in the Brazilian literature

## North America Context

### Impact on House Prices

- ❖ Each additional percentage point of remote work resulted in a 0,93% increase in house prices[1];

- ❖ Remote work contributed to a 15,1% increase in aggregate house prices in the U.S. between 2019 and 2021[1];

- ❖ Remote work explains at least half of the 23,8% increase in house prices from December 2019 to November 2021[1].

### Remote Work Persistence

- ❖ 75% of Americans who worked from home during the pandemic prefer to continue if given the option[4];

- ❖ Two-thirds of remote workers would consider moving if they could work remotely permanently[4].

### Donut Effect

- ❖ Housing demand shifted from high-density, high-cost city centers to lower-density, lower-cost suburbs and rural areas[2];

- ❖ Suburban and rural areas saw an 8% increase in real rents and a 25% increase in real house prices from 2020 to 2022[2];

- ❖ Remote work led to increased housing demand in suburban and rural areas, reflecting a preference for more spacious environments[3].

## Brazilian Context

### Adoption of Remote Work

- ❖ 65% of employees adopted remote work during the surveyed year (2020 – 2021)[5];

- ❖ 74% of respondents stated they would continue with remote work[5];

- ❖ 60% of Brazilian companies still practice remote work (2023)[6];

- ❖ 91% of people are willing to work remotely[7].

### Changed Real Estate Preferences

- ❖ The desire to change property characteristics increased: from 0,1% to 9% for buying and from 0,2% to 10% for renting[5] (2020 – 2021);

- ❖ 58% of respondents considered it important to have a remote workspace at home or in their condominium[5];

- ❖ Proximity to work lost importance by 12,5%, while having a dedicated workspace at home increased by 11,5%[5].

In North America, comprehensive studies have been conducted to assess the impact of remote work on house prices. In contrast, existing studies in Brazil primarily highlight trends rather than providing conclusive evidence of an effective impact. This disparity underscores a significant gap in the academic literature regarding the impact of remote work on the real estate market in Brazil.

Sources: [1]Mondragon & Wieland (2022), [2]Howard, Liebersohn, & Ozimek (2023), [3]PwC and Urban Land Institute (2024), [4]Zillow Research (2020), [5]DataZap+ (2020-2021), [6]Rodello & Rodrigues (2023), [7]Robert Half (2022)).

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# The real estate market experienced a demand shock due to new work arrangements during the pandemic, requiring changes and altering home prices

With a heated market undergoing changes in demand people are placing less value on proximity to their workplaces and more on having designated office spaces in their homes. This shift is reflected in property prices when purchasing homes. From a market perspective, understanding these changes in a timely manner provides a competitive advantage. Thus, this presentation aims to achieve two main objectives:
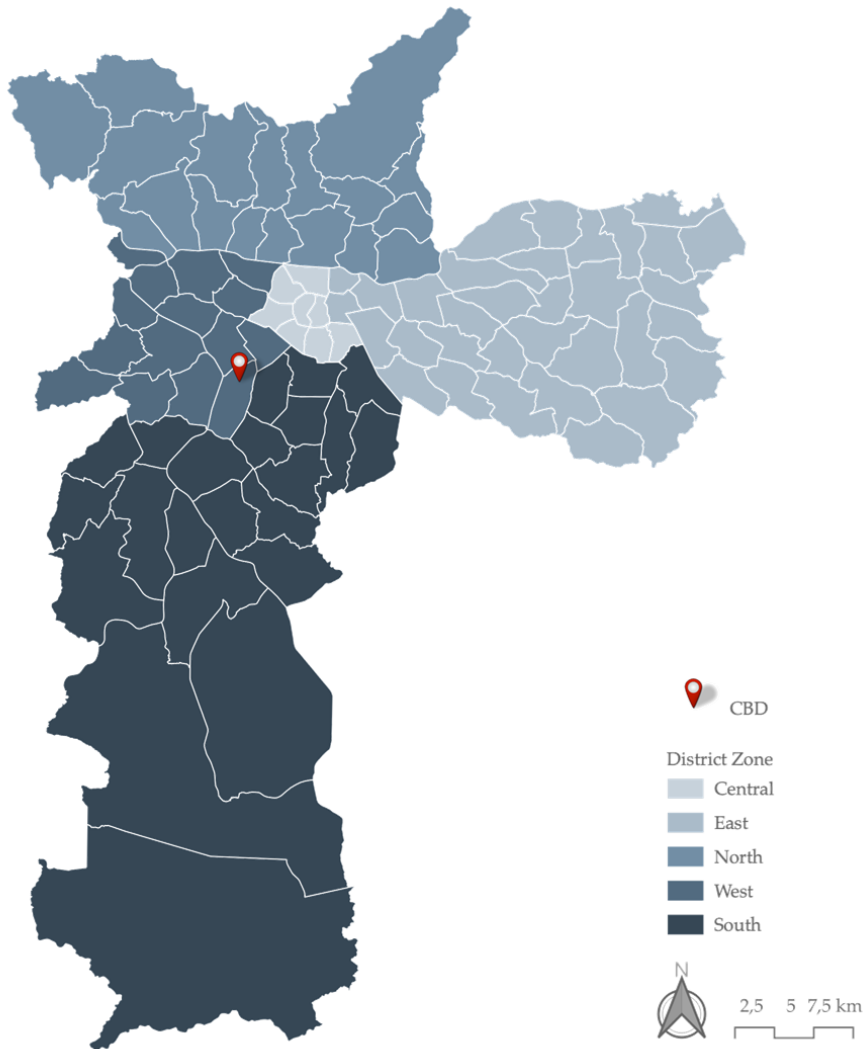
Understand the correlation between the remote work potential in São Paulo and the variation in residential sale and rental prices over time

Identify the contribution value of the remote work potential in property pricing, if it exists

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District Zone
- Central
- East
- North
- West
- South

CBD

N

2,5   5   7,5 km

- ❖ São Paulo is the largest city in Brazil, with over 12 million inhabitants and a high population density.
- ❖ The city is organized into five main zones: Central, North, South, East, and West, subdivided into 32 sub-prefectures and 96 districts.
- ❖ São Paulo is Brazil's primary economic center, contributing approximately 11% to the national GDP, driven by services, commerce, industry, and finance sectors.
- ❖ The city faces significant socioeconomic inequality, impacting residents' quality of life across different regions.
- ❖ The western regions of São Paulo exhibit better conditions compared to suburban areas, according to the performance evaluation methodology.
- ❖ São Paulo's real estate market is growing, with a projected record of 818 new condominiums in 2024, driven by low interest rates and Master Plan revisions.
- ❖ The surge in new constructions, including studios and micro-apartments, caters to the demand for smaller, affordable housing.
- ❖ Price trends indicate a significant increase in rental prices post-pandemic, reflecting economic recovery and higher demand for flexible housing options.
- ❖ The real estate market in São Paulo demonstrated resilience during the pandemic, with ongoing adaptation to new consumer expectations, such as larger spaces for home offices.

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# Regression analysis, hedonic pricing method, and occupation classifications based on remote work potential were employed to derive econometric results and economic conclusions

## Remote Work Classification Method

The remote work classification method evaluates the feasibility of different occupations being performed remotely. This method is essential to understand how remote work can influence the real estate market.

### Dingel & Neiman Methodology

❖ Classifies occupations based on their feasibility for remote work;

❖ Uses data from O*NET surveys (Work Context and Generalized Work Activities);

❖ Criteria include email usage, outdoor work, exposure to infections, and physical activity requirements.

### Barbosa, Veloso and Peruchetti Methodology

❖ Adapts Dingel & Neiman's methodology to the Brazilian context;

❖ Considers minimum infrastructure requirements, such as continuous electricity, internet, and a computer;

❖ Uses data from *PNAD Contínua* and *PNAD-COVID* to evaluate and connect teleworkability of occupations with districts;

❖ Adjusts the classification for infrastructure limitations in developing countries.

## Hedonic Price Method

The hedonic price method is used to decompose property prices into the value contributions of individual characteristics. It is applied to quantify the impact of specific attributes, such as remote work potential, on property prices.

Decomposes property prices into the value contributions of physical and locational characteristics

Allows for the monetary evaluation of the impact of remote work on property prices

Identifies how remote work potential influences housing demand and prices

Provides insights into how property attributes and location factors are valued in the market

## Regression Analysis

Regression analysis is a statistical method used to estimate the relationship between dependent and independent variables. In real estate studies, it is essential to understand how different factors influence property prices.

### Linear Regression (OLS)

❖ Estimates the relationship between remote work potential and property prices;

❖ Required to obtain initial estimates and diagnostics for spatial regression;

❖ The dependent variable used was the log of property prices in BRL, with independent variables including the remote work index, property attributes, and location factors;

❖ Assumes linearity, independence, homoscedasticity, and normality of errors.

### Spatial Regression (SLM+SEM and Durbin Model)
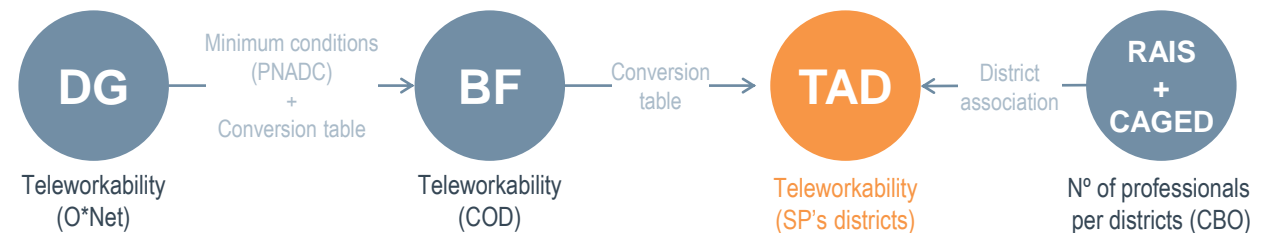
❖ Accounts for spatial dependence in property prices;

❖ The Spatial Lag Model (SLM) incorporates the spatially lagged dependent variable;

❖ The Spatial Error Model (SEM) addresses spatial autocorrelation in the error term;

❖ The Spatial Durbin Model includes spatial lags of the independent variables.

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# Remote Work Classification

1. Replicate Barbosa Filho et al.'s technique for São Paulo, utilizing minimum working conditions data from *PNAD Contínua,* to generate a "teleworkability" score for each occupation on the *COD's* classification

2. Use RAIS and New CAGED data to identify CBO's occupations and their respective average remuneration in each district of São Paulo

3. Associate remote work data with the districts using a conversion table between the CBO and COD classifications, thus providing a "teleworkability" score for each SP's district

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## Replicating Barbosa's technique, it was possible to assess the potential of remote work in the districts of São Paulo

❖ **Dingel and Neiman Methodology:** This technique evaluates the potential for workers to perform their tasks from home using data from the Occupational Information Network (O*NET), classifying occupations based on physical and social work environment factors, as well as common job behaviors, to determine the feasibility of remote work.

  ❖ **O*NET:** The Occupational Information Network (O*NET) is a comprehensive database sponsored by the U.S. Department of Labor that provides detailed descriptions and standardized information for nearly 1.000 occupations.

  ❖ **Work Context Survey:** Questions about physical and social factors in work environments, such as email usage, outdoor work, and exposure to diseases.

  ❖ **Generalized Work Activities Survey:** Questions evaluating common job behaviors, including information processing, mental activities, and interactions with others.

❖ **Barbosa Filho Methodology:** This method adapts the Dingel and Neiman approach to the Brazilian context, utilizing data from the PNAD Contínua surveys, and incorporating local infrastructure requirements like electricity, Internet access, and computers to assess the teleworkability of occupations.

  ❖ **PNAD Contínua:** is a survey conducted by the IBGE with the principal objective of furnishing continuous data on the socioeconomic characteristics to the labor force in Brazil.

  ❖ **COD Classification:** designed with the objective of enhancing the collection and analysis of data on occupations in Brazil. Its implementation commenced in household surveys conducted as part of the 2010 Demographic Census. The COD is compatible at the two-digit level with the ISCO-08 (International Standard Classification of Occupations)

  ❖ **CBO Classification:** official Brazilian classification of occupations, which represents the most detailed version. The CBO is compatible with ISCO-08 at the four-digit level and has a very similar structure to O*NET.

  ❖ **RAIS + CAGED:** administrative record that collects annual data on formal employment tracking movements in the labor market, recording the hiring and dismissal of workers.



**DG** — Teleworkability (O*Net)  →  *Minimum conditions (PNADC) + Conversion table*  →  **BF** — Teleworkability (COD)  →  *Conversion table*  →  **TAD** — Teleworkability (SP's districts)  ←  *District association*  ←  **RAIS + CAGED** — Nº of professionals per districts (CBO)

# Remote Work Classification

The RAIS and CAGED databases are based on company records, which implicitly assume that individuals live and work in the same district. Nevertheless, commuting between districts is a common practice in large cities, particularly in São Paulo, which serves as a global case study for polycentricity. To partially address this issue, the indicators were re-estimated using a spatial econometric specification. This included a spatial lag of the teleworkability index vector, utilizing a spatial weight matrix based on inter-district commuting flows, in conjunction with all other previously incorporated variables.

## Weighing remote work potential with the inter-district transport matrix yields results closer to São Paulo's reality

To improve the precision of the remote work indicator, we will employ the Total Daily Travel Matrix by Origin and Destination Zones as a means of adjustment. The rationale for employing this matrix for the purpose of adjustment is as follows:

❖ **Consideration of regional interdependencies:** the travel matrix acknowledges the interdependence between São Paulo's zones, which is crucial for understanding remote work dynamics. This approach provides a more holistic and interconnected view of the labor market;

❖ **Reduction of geographic bias:** the travel matrix mitigates geographic bias from assuming people live and work in the same district, avoiding distortions from unequal concentrations of companies or residents;

❖ **Realistic representation of commuting patterns:** the travel matrix reflects real commuting patterns, providing a more accurate picture of where workers reside and work, correcting the assumption that they live in the same district as their employers.

| | | | | | | | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|---|
| *District 1* | $C_{1,1}$ | $C_{1,2}$ | $\cdots$ | $C_{1,95}$ | $C_{1,96}$ | | $T_{1,1}$ | $T_{1,1}$ | $T_{1,1}$ | $T_{1,1}$ |
| *District 2* | $C_{2,1}$ | $C_{2,2}$ | $\cdots$ | $C_{2,95}$ | $C_{2,96}$ | | $T_{2,1}$ | $T_{2,1}$ | $T_{2,1}$ | $T_{2,1}$ |
| *District 3* | $C_{3,1}$ | $C_{3,2}$ | $\cdots$ | $C_{3,95}$ | $C_{3,96}$ | | $T_{3,1}$ | $T_{3,1}$ | $T_{3,1}$ | $T_{3,1}$ |
| | $\vdots$ | $\vdots$ | $\ddots$ | $\vdots$ | $\vdots$ | X | $\vdots$ | $\vdots$ | $\vdots$ | $\vdots$ |
| *District 94* | $C_{94,1}$ | $C_{94,2}$ | $\cdots$ | $C_{94,95}$ | $C_{94,96}$ | | $T_{94,1}$ | $T_{94,1}$ | $T_{94,1}$ | $T_{94,1}$ |
| *District 95* | $C_{95,1}$ | $C_{95,2}$ | $\cdots$ | $C_{95,95}$ | $C_{95,96}$ | | $T_{95,1}$ | $T_{95,1}$ | $T_{95,1}$ | $T_{95,1}$ |
| *District 96* | $C_{96,1}$ | $C_{96,2}$ | $\cdots$ | $C_{95,96}$ | $C_{96,96}$ | | $T_{96,1}$ | $T_{96,1}$ | $T_{96,1}$ | $T_{96,1}$ |

96x96    96x4
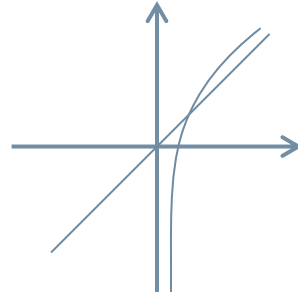
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### Advertised Values

Selling and rental prices are based on advertised values, excluding amenities due to input errors and lack of standardization

### Remote Work Potential

Refers to the potential characteristics of an occupation, not the currently practiced ones.

### Natural Logarithm

All regressions use the natural logarithm of advertised prices for both sales and rentals.

### Uniformity by District

Assumes uniform remote work potential across all listings within a district due to data granularity limitations.

### Spatial Analysis

Conducted exclusively for sales transactions from 2019 to 2021, with spatial regressions taking several hours due to high degrees of freedom.

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# After applying the technique and adaptations for remote work potential, the information was combined with housing asking prices data and social indicators, creating a unified database
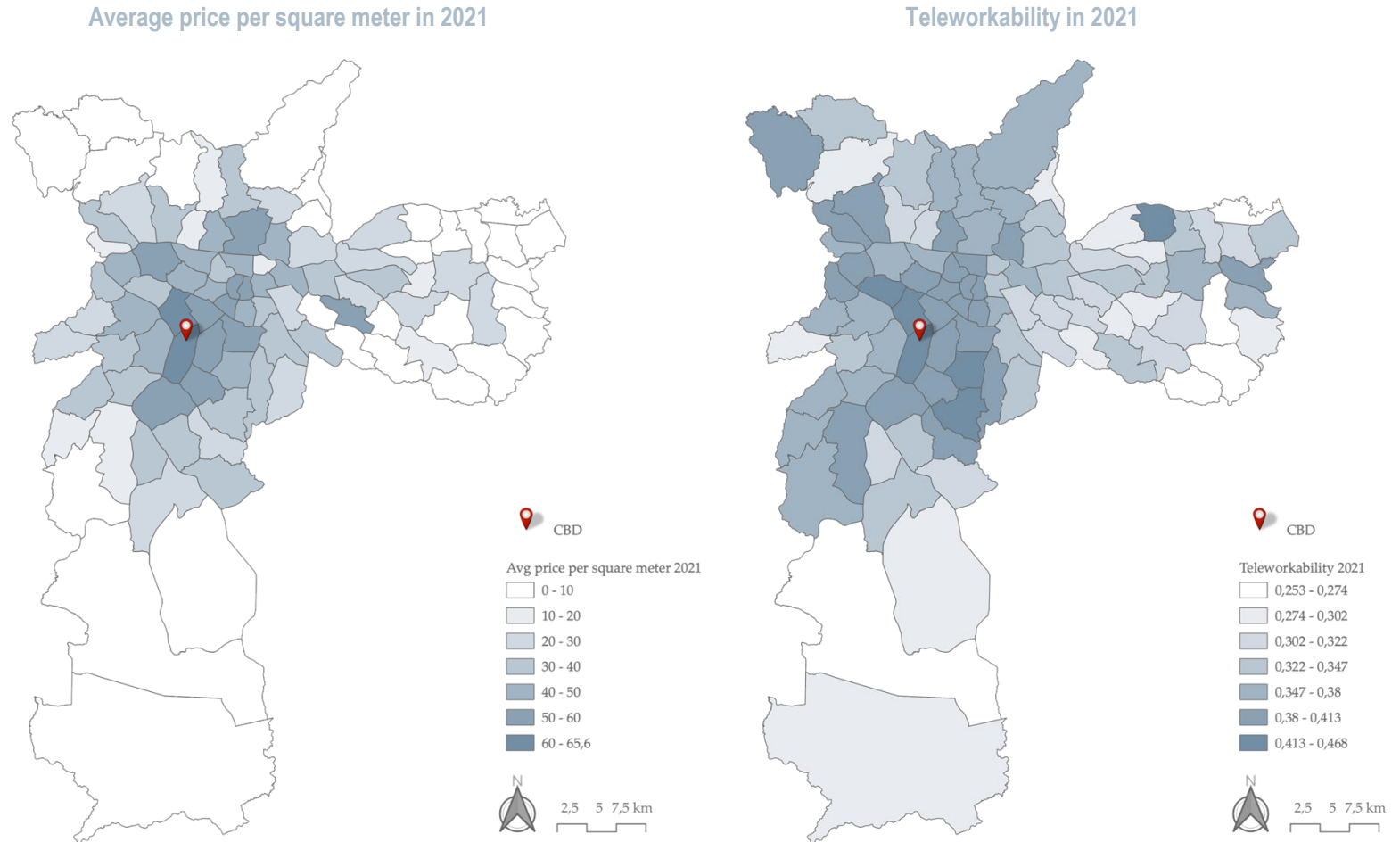
| date | area_m2 | bedrooms | suite | bathrooms | garage | price_real_month | price_m2 | condo_real | latitude | longitude | metro_dist_km | gym | field_quadra | elevator | furnished | swimming_pool | NM_DISTRIT | delta_cbd_farialima | inequality_meter | teleworkable | avg_salario_medio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23/07/2020 | 33 | 1 | 1 | 1 | 1 | 305.000 | 9.242 | 1.385 | 23,6043 | 46,6654 | 0,43 | 1 | 0 | 1 | 1 | 1 | MOEMA | 2,24 | 60,91 | 0,35 | 5.406,95 |
| 09/07/2019 | 45 | 1 | 1 | 1 | 1 | 599.000 | 13.311 | 700 | 23,6270 | 46,6633 | 2,00 | 0 | 0 | 0 | 0 | 0 | CAMPO BELO | 4,46 | 39,47 | 0,38 | 4.448,11 |
| 22/01/2020 | 52 | 1 | 1 | 1 | 2 | 950.000 | 18.269 | 800 | 23,5922 | 46,6856 | 2,61 | 1 | 0 | 1 | 0 | 1 | ITAIM BIBI | 0,47 | 64,69 | 0,49 | 7.214,62 |
| 25/06/2019 | 88 | 1 | 1 | 1 | 2 | 530.000 | 6.023 | 1.140 | 23,6199 | 46,7414 | 2,26 | 0 | 0 | 0 | 0 | 0 | VILA ANDRADE | 6,94 | 35,22 | 0,35 | 5.027,01 |
| 23/07/2019 | 88 | 1 | 1 | 1 | 2 | 530.000 | 6.023 | 1.140 | 23,6199 | 46,7414 | 2,26 | 0 | 0 | 0 | 0 | 0 | VILA ANDRADE | 6,94 | 35,22 | 0,35 | 5.027,01 |
| 23/06/2021 | 21 | 1 | 1 | 1 | 1 | 282.100 | 13.433 | | 23,6291 | 46,6911 | 0,44 | 1 | 0 | 1 | 1 | 1 | SANTO AMARO | 4,41 | 63,16 | 0,46 | 6.461,46 |
| 18/10/2019 | 25 | 1 | 1 | 1 | 1 | 200.000 | 8.000 | 250 | 23,5742 | 46,7068 | 0,31 | 0 | 0 | 0 | 0 | 0 | BUTANTÃ | 3,17 | 62,38 | 0,34 | 6.925,07 |
| 24/10/2021 | 29 | 1 | 1 | 1 | 1 | 330.000 | 11.379 | 550 | 23,5441 | 46,6473 | 0,48 | 1 | 0 | 1 | 0 | 0 | REPÚBLICA | 6,22 | 61,17 | 0,45 | 5.887,27 |
| 14/08/2019 | 33 | 1 | 1 | 1 | 1 | 415.000 | 12.576 | 539 | 23,6089 | 46,6623 | 0,64 | 0 | 0 | 0 | 0 | 0 | MOEMA | 2,82 | 71,22 | 0,36 | 5.299,68 |
| 28/04/2019 | 34 | 1 | 1 | 1 | 1 | 600.000 | 17.647 | | 23,5941 | 46,6822 | 2,22 | 0 | 0 | 0 | 0 | 0 | ITAIM BIBI | 0,41 | 62,50 | 0,52 | 7.409,96 |
| 19/09/2021 | 36 | 1 | 1 | 1 | 1 | 390.000 | 10.833 | 700 | 23,5426 | 46,6961 | 0,69 | 1 | 0 | 1 | 0 | 1 | ALTO DE PINHEIROS | 5,54 | 60,57 | 0,50 | 5.772,64 |
| 21/08/2019 | 39 | 1 | 1 | 1 | 1 | 449.000 | 11.513 | 390 | 23,5687 | 46,7002 | 0,25 | 0 | 0 | 0 | 0 | 0 | PINHEIROS | 3,09 | 65,81 | 0,54 | 6.352,54 |
| 12/09/2021 | 40 | 1 | 1 | 1 | 1 | 349.999 | 8.750 | 1.100 | 23,6010 | 46,6662 | 0,52 | 1 | 0 | 1 | 1 | 1 | MOEMA | 1,93 | 65,28 | 0,47 | 5.736,18 |
| 27/10/2021 | 40 | 1 | 1 | 1 | 1 | 500.000 | 12.500 | 415 | 23,5535 | 46,6380 | 0,30 | 1 | 0 | 1 | 1 | 1 | REPÚBLICA | 6,03 | 61,17 | 0,45 | 5.887,27 |
| 16/06/2019 | 42 | 1 | 1 | 1 | 1 | 468.000 | 11.143 | 400 | 23,6141 | 46,6886 | 0,84 | 0 | 0 | 0 | 0 | 0 | ITAIM BIBI | 2,72 | 62,50 | 0,52 | 7.409,96 |
| 08/07/2021 | 43 | 1 | 1 | 1 | 1 | 680.000 | 15.814 | 500 | 23,5541 | 46,6507 | 0,64 | 0 | 0 | 1 | 0 | 0 | BELA VISTA | 5,11 | 59,31 | 0,63 | 6.230,49 |
| 28/08/2021 | 43 | 1 | 1 | 1 | 1 | 520.000 | 12.093 | 800 | 23,5616 | 46,6508 | 0,34 | 1 | 0 | 1 | 0 | 1 | BELA VISTA | 4,47 | 59,31 | 0,63 | 6.230,49 |
| 24/01/2019 | 44 | 1 | 1 | 1 | 1 | 235.000 | 5.341 | 260 | 23,6346 | 46,7378 | 0,96 | 0 | 0 | 0 | 0 | 0 | VILA ANDRADE | 7,56 | 35,22 | 0,35 | 5.027,01 |
| 24/01/2019 | 44 | 1 | 1 | 2 | 1 | 435.000 | 9.886 | | 23,5813 | 46,6352 | 0,29 | 0 | 0 | 0 | 0 | 0 | VILA MARIANA | 4,81 | 68,97 | 0,28 | 5.415,69 |
| 28/08/2019 | 48 | 1 | 1 | 2 | 1 | 600.000 | 12.500 | 700 | 23,5488 | 46,6453 | 0,59 | 0 | 0 | 0 | 0 | 0 | REPÚBLICA | 5,91 | 56,10 | 0,50 | 5.632,36 |

🟧 The dataset consists of house asking prices extracted from the VivaReal platform from 2018 to 2021, using a web scraping technique

🟥 Values calculated through differences in latitude and longitude extracted from the addresses of the asking prices using a Google Maps API

🟪 Values sourced from *Rede Nossa São Paulo*, a non-governmental, non-profit organization that generates social indicators annually

🔵 Values generated using the Barosa Filho technique for the districts of São Paulo, weighted by the matrix of daily commute weights between districts

🟩 Data generated by RAIS + CAGED

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# Regression Analysis

Performing the OLS linear regression, statistical tests for residual normality, heteroscedasticity, and autocorrelation (Shapiro-Wilk, Breusch-Pagan, and Durbin-Watson) indicated some violations of the regression model assumptions. Therefore, non-linear transformations were applied, the log of the property price was used, and possible spatial dependencies were investigated. Analyzing graphs of price per square meter and remote work data, a possible clustering in the western zone of the city was noted, leading to further tests being conducted.

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## Clustering of prices and remote work potential in the western zone motivated a spatial Durbin regression



Average price per square meter in 2021

CBD

Avg price per square meter 2021
- 0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 65,6

2,5  5  7,5 km

Teleworkability in 2021

CBD

Teleworkability 2021
- 0,253 - 0,274
- 0,274 - 0,302
- 0,302 - 0,322
- 0,322 - 0,347
- 0,347 - 0,38
- 0,38 - 0,413
- 0,413 - 0,468

2,5  5  7,5 km

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## Spatial dependence in the independent variables led to the Durbin regression using the k-nearest neighbors' matrix

The Robust Spatial Error (RSer) and Robust Spatial Lag (RSlag) tests showed significant p-values, indicating strong spatial dependence in the independent variables. This confirmed the initial suspicion of spatial autocorrelation, highlighting the need for a spatial regression approach

| Test | Sell 2019 | Sell 2020 | Sell 2021 |
|---|---|---|---|
| Roboust Spatial Error (RSerr) | 2184,8 (0,00)*** | 546,04 (0,00)*** | 682,68 (0,00)*** |
| Roboust Spatial Lag (RSlag) | 1133,6 (0,00)*** | 349,97 (0,00)*** | 356,91 (0,00)*** |
| Adjusted Robust Spatial Error (adjRSerr) | 1117,8 (0,00)*** | 212,26 (0,00)*** | 325,82 (0,00)*** |
| Adjusted Robust Spatial Lag (adjRSlag) | 66,658 (0,00)*** | 16,19 (0,00)*** | 0,05135 (0,8207) |
| Spatial Autoregressive Moving Average (SARMA) | 2251,5 (0,00)*** | 542,24 (0,00)*** | 682,73 (0,00)*** |

*P-value between parentheses: 0 < *** < 0,001 < ** < 0,01 < * < 0,05 < · < 0,1 < " " < 1*

The Spatial Durbin Model (SDM) enhances the spatial lag model by incorporating spatial lags of the independent variables as well as the dependent variable. This allows for a more comprehensive analysis of spatial relationships. The model is represented as follows:

$$y = \rho W y + X\beta + W X\theta + \epsilon$$

Log(price)

Teleworkability    Metro Distance
Area    CBD distance
N° Bedrooms    Inequality meter
N° Bathrooms    Avg. Wage on the district

❖ ρ is the spatial autoregressive parameter for the dependent variable;

❖ W is the spatial weights matrix using k-nearest neighbors with k = 3;

❖ X is the matrix of explanatory variables;

❖ β is the vector of coefficients for the explanatory variables;

❖ WXθ represents the spatially lagged independent variables with θ (theta) being the associated coefficients;

❖ ϵ is a vector of independently and identically distributed error terms.

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The results indicate that teleworkability had no significant impact in 2019, a positive impact in 2020, and a potential positive impact in 2021

Rho coefficients are significant across all years, indicating spatial dependencies

LR, z-value, and Wald tests confirm the statistical significance of the spatial terms, showing that they have an important impact on the dependent variables

High log-likelihood values suggest that the model effectively explains the data for 2019, 2020, and 2021

| | Sell – Spatial Durbin Model | | | Sell – Lag Spatial Durbin Model | | |
|---|---|---|---|---|---|---|
| | **2019** | **2020** | **2021** | **2019** | **2020** | **2021** |
| **Intercept** | 5,7862 (0,00)*** | 4,233 (0,00)*** | 3,664 (0,00)*** | - | - | - |
| **Teleworkability** | **-0,24524 (0,690)** | **1,7604 (0,006)**** | **1,252 (0,078)** · | 0,774 (0,2147) | -1,545 (0,021)* | -0,997 (0,174) |
| **Area** | 0,00712 (0,00)*** | 0,00873 (0,00)*** | 0,0105 (0,00)*** | -0,00328 (0,00)*** | -0,0049 (0,00)*** | -0,00767 (0,00)*** |
| **Bedrooms** | 0,0803 (0,00)*** | -0,029 (0,004)** | -0,077 (0,00)*** | -0,0782 (0,00)*** | -0,0135 (0,386) | 0,0052 (0,004)** |
| **Bathrooms** | 0,0960 (0,00)*** | 0,044 (0,001)6** | -0,0014 (0,402) | 0,00678 (0,3673) | -0,096 (0,00)*** | 0,0173 (0,447) |
| **Metro Distance** | 0,0093 (0,749) | 0,021 (0,359) | 0,0247 (0,342) | -0,0005 (0,9868) | -0,0152 (0,519) | -0,0030 (0,234) |
| **CBD distance** | -0,025 (0,325) | -0,111 (0,00)*** | -0,0520 (0,008)** | 0,0189 (0,458) | 0,0946 (0,00)*** | 0,0433 (0,028)* |
| **Inequality meter** | 0,00191 (0,443) | 0,0045 (0,059)* | -0,0014 (0,607) | 0,00166 (0,5063) | -0,0417 (0,092) · | 0,0054 (0,059)· |
| **Avg. Wage** | $2,6 \cdot 10^{-5}$ (0,1968) | $-4,5 \cdot 10^{-5}$ (0,02) · | $-2,3 \cdot 10^{-5}$ (0,265) | $-3,2 \cdot 10^{-5}$ (0,1128) | $3,4 \cdot 10^{-5}$ (0,1164) | $1,0 \cdot 10^{-5}$ (0,644) |
| **Number of observations** | 6648 | 641 | 787 | 6648 | 641 | 787 |
| **Rho** | 0,49615 | 0,67867 | 0,70209 | 0,49615 | 0,67867 | 0,70209 |
| **LR Test** | 1614 (0,00)*** | 422,85 (0,00)*** | 537,16 (0,00)*** | 1614 (0,00)*** | 422,85 (0,00)*** | 537,16 (0,00)*** |
| **z-value** | 48,40 (0,00)*** | 30,672 (0,00)*** | 36,983 (0,00)*** | 48,40 (0,00)*** | 30,672 (0,00)*** | 36,983 (0,00)*** |
| **Wald Test** | 2342,6 (0,00)*** | 940,77 (0,00)*** | 1367,7 (0,00)*** | 2342,6 (0,00)*** | 940,77 (0,00)*** | 1367,7 (0,00)*** |
| **Log Likelihood** | 940,8726 | 406,148 | 297,1926 | 940,8726 | 406,148 | 297,1926 |
| **Sigma²** | 0,0413 | 0,0146 | 0,023956 | 0,0413 | 0,0146 | 0,023956 |
| **Akaike Inf. Crit.** | -1843,7 | -774,3 | -556,39 | -1843,7 | -774,3 | -556,39 |
| **LM test** | 28,347 (0,00)*** | 4,795 (0,0285)* | 2,7579 (0,0097)** | 28,347 (0,00)*** | 4,795 (0,0285)* | 2,7579 (0,0097)** |

*P-value between parentheses: 0 < *** < 0,001 < ** < 0,01 < * < 0,05 < · < 0,1 < " " < 1*

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# Comprehensive conclusion on research findings, study limitations, and future research directions

❖ The Spatial Durbin Model (SDM) indicated a non-significant impact in 2019 (-0,24524), a significant positive impact in 2020 (1,7604), and a non-significant positive impact in 2021 (1,252). This variability suggests **the economic impact of remote work on property prices fluctuated over the years**, possibly influenced by the evolving nature of the pandemic and remote work practices.

❖ The **underlying data and model assumptions warrant careful interpretation,** as the non-significance of some variables and the potential for heteroscedasticity and autocorrelation in the non-spatial models suggest these findings should be seen as indicative rather than definitive.

❖ The **areas of advertisement analyzed in this study may have introduced some perturbations in the results**, and future investigations should expand the scope of these areas to ensure more comprehensive coverage and potentially more robust results.

❖ Some simplifications made during the analysis could have impacted the results, and future studies should aim to address these simplifications using more detailed data and refined econometric techniques to enhance the reliability and validity of the results.

❖ The relationship between teleworkability and property prices shows significant variability over the years, with the SDM model highlighting a notable positive impact in 2020.This underscores the dynamic interaction between remote work and property prices, reflecting broader changes in housing demand driven by the pandemic and evolving work practices.

❖ Future research should focus on expanding the scope of analysis and addressing simplifications to further refine these insights and improve the robustness of the findings.

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# Questions?

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D&G: If any of the following conditions in the *Work Context* survey responses are true for an occupation, that occupation will be classified as incompatible with remote working:

❖ Average respondent says they use email less than once per month (Q4)

❖ Average respondent says they deal with violent people at least once a week (Q14)

❖ Majority of respondents say they work outdoors every day (Q17 & Q18)

❖ Average respondent says they are exposed to diseases or infection at least once a week (Q29)

❖ Average respondent says they are exposed to minor burns, cuts, bites, or stings at least once a week (Q33)

❖ Average respondent says they spent majority of time walking or running (Q37)

❖ Average respondent says they spent majority of time wearing common or specialized protective or safety equipment (Q43 & Q44)

D&G: If any of the following conditions in the *Generalized Work Activities* survey responses are true for an occupation, that occupation will be classified as incompatible with remote working:

❖ Performing General Physical Activities is very important (Q16A)

❖ Handling and Moving Objects is very important (Q17A)

❖ Controlling Machines and Processes [not computers nor vehicles] is very important (Q18A)

❖ Operating Vehicles, Mechanized Devices, or Equipment is very important (Q20A)

❖ Performing for or Working Directly with the Public is very important (Q32A)

❖ Repairing and Maintaining Mechanical Equipment is very important (Q22A)

❖ Repairing and Maintaining Electronic Equipment is very important (Q23A)

❖ Inspecting Equipment, Structures, or Materials is very important (Q4A)

BF: This variable takes the value of **1 for workers whose households possess all three specified items and 0 for those who do not meet any of these criteria**

❖ How often is electricity from the general network usually available for this household? (S01015)

❖ Does this household have a computer (including portable ones such as laptops, notebooks, ultrabooks, or netbooks)? (S01028)

❖ Does any resident have internet access at home through a computer, tablet, mobile phone, television, or other equipment? (S01029)

❖ Occupation code (position or function) (V4010)

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