Urban Welfare Analysis Using Within-City Areas

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Abstract

This paper presents an analysis of urban welfare in Brazil by introducing a Spatial Cost of Living Index (SCOL) that utilizes detailed household expenditure data at the within-city area level. By adjusting consumption-based welfare indicators for regional price differences, the study provides a more accurate depiction of poverty and inequality across urban landscapes. The findings reveal significant variations in living costs among Brazilian states and metropolitan areas, impacting poverty assessments. Notably, while the North and Northeast regions are the poorest in absolute terms, cost of living adjustments indicate that poverty is more prevalent in the Southeast and South than nominal figures suggest, highlighting the vulnerability of specific areas in wealthier regions. The analysis underscores the limitations of relying solely on nominal income or expenditure figures, as incorporating spatial price variations alters poverty headcount ratios and reshapes the understanding of regional disparities. Sensitivity tests confirm the robustness of SCOL-adjusted estimates across various poverty thresholds.

JEL Codes: R13, R20, R29.
Keywords: welfare, consumption expenditure, Cost of living Index, Urban center.

Resumo

Este artigo apresenta uma análise do bem-estar urbano no Brasil ao introduzir um Índice Espacial de Custo de Vida (SCOL) que utiliza dados detalhados de despesas familiares em nível de área dentro da cidade. Ao ajustar os indicadores de bem-estar baseados no consumo para as diferenças de preços regionais, o estudo oferece uma representação mais precisa da pobreza e da desigualdade nas paisagens urbanas. Os achados revelam variações significativas nos custos de vida entre os estados e áreas metropolitanas brasileiras, impactando as avaliações de pobreza. Notavelmente, enquanto as regiões Norte e Nordeste são as mais pobres em termos absolutos, os ajustes de custo de vida indicam que a pobreza é mais prevalente nas regiões Sudeste e Sul do que os números nominais sugerem, destacando a vulnerabilidade de áreas específicas em regiões mais ricas. A análise ressalta as limitações de se basear apenas em figuras nominais de renda ou despesa, pois a incorporação de variações de preços espaciais altera as taxas de contagem da pobreza e reformula a compreensão das disparidades regionais. Testes de sensibilidade confirmam a robustez das estimativas ajustadas pelo SCOL em vários limiares de pobreza.

Códigos JEL: R13, R20, R29.
Palavras-chave: bem-estar, gastos em consumo, índice de custo de vida, centros Urbanos.

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1 INTRODUCTION

Understanding urban poverty and inequality requires going beyond broad regional comparisons to examine disparities within individual cities. This study offers a novel approach to welfare analysis in Brazil by focusing on *within-city areas*, sing the most granular geographic units available in the national household expenditure data. Leveraging this disaggregated data, we construct a Spatial Cost of Living Index (SCOL) for the first time at the within-city area level, enabling a more precise adjustment of consumption values and, consequently, a more accurate identification of well-being. Grounded in a consumption-based definition of welfare, the analysis circumvents limitations posed by nominal income metrics and highlights the impact of geographic price differences on poverty measurements. Through this lens, the research reveals spatially uneven cost-of-living burdens across Brazilian regions, providing critical insights into the socioeconomic inequalities embedded within urban landscapes.

The concern with welfare is present in various sources. Seeking to avoid the limitations of using income alone to evaluate welfare, the Human Development Index presented by the United Nations includes income, education, and wealth to produce an indicator of the level of development of countries worldwide[1]. The Wellbeing Research Centre at the University of Oxford publishes the World Happiness Report (WHR) annually, combining objective and subjective variables[2]. A similar study, applied to Brazil, included 12 dimensions of welfare for all Brazilian cities[3], resulting in a ranking of well-being among them. Although several aspects of living contribute to the welfare of human beings, income, and consumption are part of the problem. However, nominal income levels may represent distinct access to goods and services in countries with different cost-of-living conditions. To facilitate purchasing power parity comparison among countries, the World Bank established the International Comparison Program, providing Purchasing Power Parity-based GDP per capita for countries[4] regularly. A central part of this process is the construction of a Cost-of-Living Index for each geographical unity. In the Brazilian case, geographical cost-of-living indexes are only available for some of its metropolitan areas. Menezes (1999) presented the first consistent spatial cost of living index for Brazilian regions, based on the 1997 household expenditure survey produced by IBGE; Azzoni *et al*. (2000) extended the index of the 11 metropolitan areas for the period 1981-1999; Almeida

[1] United Nation Development Reports, Human Development Report 2025: https://hdr.undp.org/content/human-development-report-2025.
[2] Helliwell, J. F., Layard, R., Sachs, J. D., De Neve, J.-E., Aknin, L. B., & Wang, S. (Eds.). (2025). World Happiness Report 2025. University of Oxford: Wellbeing Research Centre: https://files.worldhappiness.report/WHR25.pdf?_gl=1*1bbzfr3*_gcl_au*MjE0NjU5Nzc5NC4xNzUxNTc5ODQ1.
[3] Revista Bula: https://www.revistabula.com/99696-1-as-50-cidades-mais-felizes-do-brasil-em-2025-com-base-nos-criterios-da-onu/
[4] https://www.worldbank.org/en/programs/icp/data.

and Azzoni (2016) updated the index for the period 1996-2014, using the 2007 survey; Almeida and Azzoni (2021), using the 2017-2018 survey, organized the series from 1996 through 2020 and studied how the regional consumption structures evolved over the period. The cited studies concentrated on a few metropolitan regions, overlooking all other cities. To extend the information on cost-of-living differences geographically, Azzoni and Seabra (2018) used data from the 2010 demographic census to estimate a spatial rent cost index for all cities and census weighting areas within them. Even with this geographical improvement, this research effort concentrated only on rent costs.

In this paper, we produce cost of living indexes for all Brazilian states for 2018 and use them to adjust consumption levels. The index at the state level expands the geographical scope, as previous efforts focused on a few metropolitan areas. Using price-adjusted consumption levels, we produce a consumption-based welfare analysis of the country's within-city areas. This is an important step forward, as there is relevant consumption heterogeneity between cities located outside metropolitan areas, the capital city, and cities within metropolitan areas. Dealing with PSA advances also by considering the existing heterogeneity within the capital and large cities.

The paper is organized into five sections, including this Introduction. Section 2 presents the 2017-2018 national household expenditure survey data used based on the. Section 3 provides information on the construction of the Spatial Cost of Living Index. The welfare analysis based on price-adjusted consumption levels is detailed in Section 4. The final section presents the conclusions of the analysis.

2 DATA SET

The primary data source is the Household Expenditure Survey, produced by IBGE, Brazil's official statistics office[5]. During parts of 2017 and 2018, the survey interviewed monthly 58,039 consumption unities, with 178,369 residents, representing around 69 million households. The database includes information on the consumption structure, expenditure, and income, as well as on household and personal characteristics. The data is available at the primary sampling area (PSA) level, which is the most disaggregated geographical level of information available. Our consumption unities are the averages of the 4,598 urban PSAs, with information on the consumption structure, number of households, residents, income, and some socioeconomic characteristics.

The PSA is the smallest territorial unity selected at the survey sampling stage, considering geographical and socioeconomic homogeneity. Unfortunately, the information on PSAs location only allows identifying the state, whether the PSA is in the state's capital city, in other metropolitan cities

[5] IBGE, Pesquisa de Orçamentos Familiares: https://www.ibge.gov.br/en/statistics/social/health/25610-pof-2017-2018-pof-en.html?lang=en-GB.

(if the state has an official metropolitan area), or in other state cities. The total number of households in the PSAs is the basis for selecting the households included in the survey's sample. Table 1 presents basic statistics for the PSAs across states and macro-regions.

We use expenditure on food items and rent as a consumption-based welfare indicator, a choice made based on information availability. Although we leave out other items in the household consumption structures, such as education, health, transportation, etc., the two expenditure groups account for a large part of total consumption (Menezes *et al*., 2007). They are highly correlated with the aggregate Spatial Cost of Living Index (Menezes *et al*., 2007). Therefore, even if we use partial information on consumption expenditure, the groups we use are a good indicator of cost-of-living differences across space.

We divide the expenditure on the consumption of each food item by the number of people in the PSA, arriving at a per capita expenditure indicator for each item at the PSA level. The gross per capita income[6] for each PSA follows the same procedure. There is information on the quantities purchased for 974 food items, allowing the calculation of *unit values* (*UVs*) by dividing total expenditure on the item by the quantity purchased, thereby generating proxies for food prices. We use the estimated rent of the building as the rent unity value on the plausible assumption that there is only one household per building. The final sample includes 44,710 households, corresponding to over 59 million consumption unities in the population (Tables 2 and 3, and Figure 1). The *UV* allowed the estimation of a Spatial Cost of Living Index – SCOL, which includes 974 in-household food consumption items and an estimated rent value.

6 The gross monetary income includes monetary and non-monetary income from all sources, for all household members, equity changes (income from real estate sales, heritages, etc., and changes in savings).

Table 1 – Primary Sampling Areas (PSA), Households, Products and Per Capita Expenditure, by State

Macro Region	State	# PSAs	# HH	# Products	Average per capita expenditure
North	RO	71	653	812	281
	AC	85	814	844	245
	AM	155	1,498	954	234
	RR	72	682	684	296
	PA	99	836	894	211
	AP	62	618	856	198
	TO	79	716	716	323
Northeast	MA	152	1,541	974	185
	PI	123	1,395	912	205
	CE	225	2,196	1,038	225
	RN	115	1,253	1,063	225
	PB	148	1,474	1,003	250
	PE	279	2,672	1,170	260
	AL	144	1,530	921	269
	SE	126	1,227	953	243
	BA	239	2,273	1,192	261
Southeast	MG	329	3,350	1,303	312
	ES	280	2,751	1,072	442
	RJ	311	2,877	1,138	451
	SP	354	3,417	1,335	440
South	PR	218	2,129	1,151	377
	SC	188	1,937	1,198	379
	RS	234	2,150	1,229	376
Mid-West	MS	138	1,357	1,067	308
	MT	113	1,107	945	346
	GO	130	1,225	1,004	331
	DF	129	1,194	1,139	571

Source: IBGE, POF – Pesquisa de Orçamentos Familiares, 2017-2018.

We use expenditure on food items and rent as a consumption-based welfare indicator, a choice made based on information availability. Table 2 exhibits general information on the characteristics of the households included in the sample. Per capita income values range from BRL 1,133 in the state of Maranhão (MA) in the Northeast region to BRL 6,312 in Brasília (DF). Table 3 provides information on the calculated average *unit values* (prices) for the states. Again, there is heterogeneity in the values, varying from BRL 66,70 in the state of Sergipe in the Northeast region to BRL 147.09 in Brasília. The

UV standard deviation is high in all states. Figure 1 displays the distribution of the number of households and the per capita expenditure by state and region.

Table 2 – Per capita income and sociodemographic characteristics.

	Per capita income (BRL)	**age average**	**# people in hh**	**% White hh head**	**% Black hh head**	**% Women hh head**	**% Receiving Govnt Cash Transfers**	**% in Metropolitan Region**
RO	1.690.47	45	3.24	0.68	0.09	0.51	0.06	0.00
AC	1.607.24	45	3.72	0.84	0.08	0.59	0.24	0.00
AM	1.510.92	46	4.13	0.76	0.06	0.46	0.26	0.00
RR	1.545.59	46	3.94	0.75	0.09	0.53	0.14	0.00
PA	1.398.15	48	3.82	0.80	0.12	0.39	0.24	0.39
AP	1.515.06	46	4.06	0.80	0.10	0.43	0.21	0.00
TO	1.378.62	47	3.31	0.86	0.19	0.59	0.15	0.00
MA	1.133.30	49	3.77	0.78	0.14	0.46	0.37	0.00
PI	1.611.15	51	3.46	0.78	0.11	0.45	0.23	0.00
CE	1.548.77	50	3.46	0.71	0.09	0.50	0.25	0.57
RN	1.814.98	50	3.47	0.58	0.08	0.40	0.20	0.00
PB	1.906.43	51	3.18	0.63	0.07	0.52	0.22	0.00
PE	1.930.33	50	3.21	0.65	0.10	0.41	0.20	0.54
AL	1.287.41	50	3.35	0.73	0.10	0.45	0.20	0.00
SE	1.973.71	49	3.22	0.72	0.12	0.48	0.24	0.00
BA	2.255.22	50	3.20	0.79	0.26	0.43	0.21	0.43
MG	2.532.60	52	3.14	0.53	0.13	0.39	0.07	0.28
ES	2.743.94	50	2.98	0.54	0.13	0.37	0.05	0.55
RJ	2.981.71	52	3.00	0.51	0.17	0.46	0.06	0.76
SP	3.565.76	52	3.06	0.33	0.08	0.35	0.05	0.48
PR	2.880.04	49	3.05	0.29	0.05	0.45	0.03	0.38
SC	2.706.84	50	2.91	0.15	0.03	0.41	0.02	0.00
RS	3.428.62	51	2.79	0.19	0.07	0.47	0.04	0.44
MS	2.609.40	49	3.17	0.58	0.10	0.36	0.10	0.47
MT	2.672.10	48	3.35	0.61	0.13	0.42	0.08	0.00
GO	2.624.86	49	3.08	0.58	0.11	0.37	0.07	0.46
DF	6.311.95	49	3.21	0.53	0.13	0.42	0.04	1.00

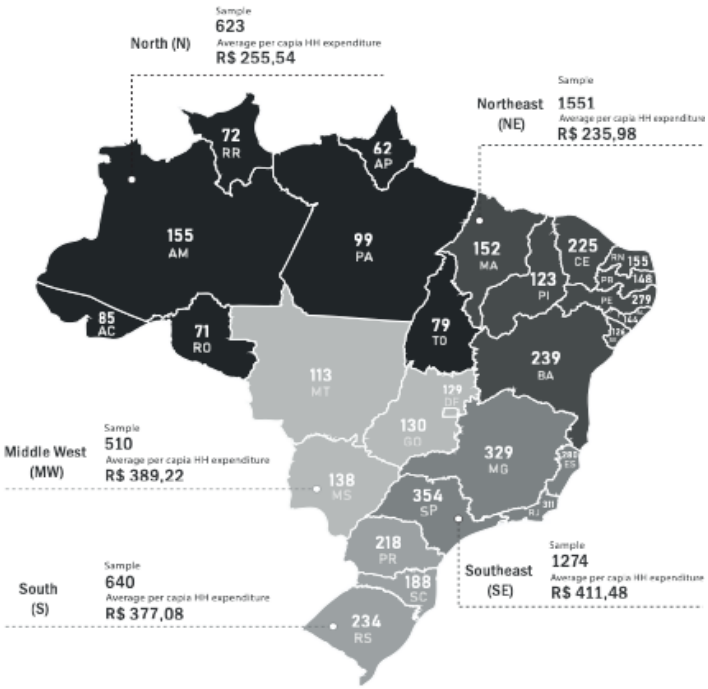
Source: IBGE, POF – Pesquisa de Orçamentos Familiares, 2017-2018.

Table 3 – Average *unit values*

State	uv *A*verage	St. Dev.
RO	99.81	210.29
AC	81.68	190.82
AM	79.14	223.70
RR	82.07	193.67
PA	73.44	162.27
AP	70.55	181.31
TO	103.37	189.66
MA	66.27	134.33
PI	67.34	134.49
CE	69.17	153.66
RN	71.51	150.11
PB	72.59	151.61
PE	75.61	184.29
AL	75.84	181.16
SE	66.70	149.23
BA	72.82	192.14
MG	92.56	217.94
ES	110.40	253.47
RJ	117.15	335.74
SP	124.68	442.63
PR	99.64	240.31
SC	105.73	263.96
RS	104.85	259.69
MS	99.80	236.58
MT	105.13	232.13
GO	99.14	632.94
DF	147.09	458.75

Source: IBGE, POF – Pesquisa de Orçamentos Familiares, 2017-2018.

Figure 1 – Number of PSA and average HH per capita expenditure



3 ESTIMATING A SPATIAL COST OF LIVING INDEX – SCOL

Finding local prices of consumption items is challenging, as such information is scarce. If a household expenditure survey is available, as in this case, *unity values* are a practical alternative to measuring the geographical variation of prices. Nevertheless, they have limitations, as problems of quality and preferences might bias the indicator (Deaton, 1988). A simple way to deal with heterogeneity and quality bias is to work with primary sampling unities (Mancini and Vecchi, 2022):

$$ln(uv_{ihk}) = \theta_1 \ln(x_{hk}) + \theta_3 X_{hk} + \sum_{i=1}^{N} \delta_i D_i + \sum_{k=2}^{K} \lambda_k D_k + \zeta_{ihk} \quad \textbf{(1)}$$

where ln (uv_{ih}) is the neperian log of the *unity value* product i, purchased by household h, living in state k; ln (x_{hk}) is the neperian log of per capita gross income of household h; D_i is a product dummy; D_k is a state dummy; X_{hk} are demographic characteristics of household h living in state k; ζ_{ihk} is the error term. The coefficient λ_k gives the cost-of-living differential across states, free of the quality and preference biases (Chen and Ravallion, 1996; Deaton, 1997). Expression (1) is estimated with WLS.

The participation of product i in the consumption basket of state k, w_{jk}, is given by:

$$w_{ik} = \left(\frac{q_{ik}}{\sum_{k=1}^{N} q_{ik}}\right) = \left(\frac{\sum_{k=1}^{K} p_{ik} q_{ik}}{\sum_{i=1}^{N} \sum_{k=1}^{K} p_{ik} q_{ik}}\right) \quad \textbf{(2)}$$

Under the model hypotheses, $\tau_k = \exp(\hat{\lambda}_k)$ is a consistent estimator of the relative prices of state k in relation to the base state. Therefore, it is a transitive multilateral price index between the k states and the base state (Selvanathan and Rao, 1994).

We have estimated equations **(1)** with the data described in Section 2, producing a SCOL for each PSA of each state. Table 4 presents the results, with Brasília as the comparison basis. The coefficients on the control variables are statistically significant at 1% and have the expected signs. Cost of living levels increase with income, age, number of people in the household. Families headed by a woman and households living in metropolitan regions have higher cost of living levels, and those headed by blacks and other non-whites, and receiving government social policy related cash transfers face lower cost of living levels (as compared to whites and those that do not receive transfers).

The state dummy variable coefficients are of interest in the estimation of the SCOL. The state of Amazonas, in the North, Rio de Janeiro and São Paulo, in the richer southeast region, face higher COL than Brasília, the country´s capital city. This area hosts the main government agencies, employing high-level civil servants, with top salaries. All sorts of sophisticated government-related private organizations, including lobbyists and national associations of sectors headquarters are also located there. The remaining states present lower COL levels as compared to Brasília (SC is not significantly

different). The results are as expected, except for Amazonas. This state's economy is dominated by the free import zone located in its capital city, Manaus. The city hosts several big multinational assembling plants, which deliver their products to the rest of the country. The remaining areas of the state are composed of small, isolated river cities in the middle of the Amazon jungle.

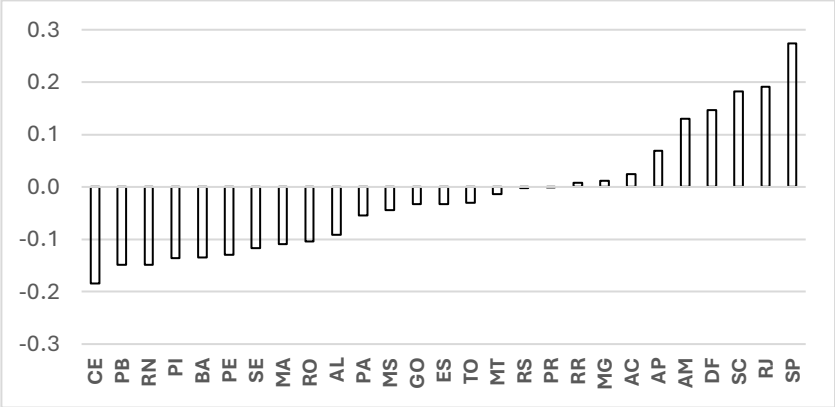
Column C in the table shows the calculated SCOL, which is plotted in Figure 2. All states in the poor Northeast region present lower-than-average COL levels and the rich states of the southeast and south show the higher COL levels, with São Paulo with the highest level.

Table 4 – Regression results. Dependent variable ln(*uv*) and Federal district dummy=1

	Coef (A)	p<|t| (B)	SCOL[(1)] (C)
HH per capita income	0.408	0.000	
Age average	0.004	0.000	
# people in the HH	0.126	0.000	
Non-white HH Head	-0.100	0.000	
Black HH Head	-0.042	0.000	
Woman HH head	0.021	0.001	
Gov. Tansfers	-0.108	0.000	
Metropolitan Region	0.215	0.000	
RO	-0.247	0.000	0.781
AC	-0.113	0.000	0.893
AM	-0.014	0.577	0.986
RR	-0.130	0.000	0.878
PA	-0.193	0.000	0.825
AP	-0.071	0.017	0.931
TO	-0.168	0.000	0.845
MA	-0.253	0.000	0.777
PI	-0.284	0.000	0.753
CE	-0.340	0.000	0.712
RN	-0.298	0.000	0.742
PB	-0.299	0.000	0.742
PE	-0.276	0.000	0.758
AL	-0.233	0.000	0.792
SE	-0.261	0.000	0.770
BA	-0.282	0.000	0.755
MG	-0.125	0.000	0.882
ES	-0.170	0.000	0.843
RJ	0.038	0.078	1.038
SP	0.105	0.000	1.111
PR	-0.138	0.000	0.871
SC	0.030	0.207	1.030
RS	-0.140	0.000	0.869
MS	-0.183	0.000	0.833
MT	-0.151	0.000	0.860
GO	-0.171	0.000	0.843
DF			1.000
Product dummmy	Yes		
# Obs	476,219		
R2-Adjusted	0.9885		

(1) column (A) coefficients exponential.
Number of observations =
(number of PSA * number of consumption items in each PSA).

Figure 2 – Spatial Cost of Living Index



4 MEASURING WELFARE BETWEEN AREAS

Poverty and welfare comparisons typically use per capita household expenditures. However, this indicator is plagued by price differences, both over time (inflation) and across regions within countries, through geographical cost of living differences (Ravallion, 1994, 2016). The Money-Metric Utility (MMU) proposed by Deaton and Zaidi (2002) is a welfare measure consistent with the consumer theory. Ideally, by adjusting the nominal expenditure by the True Cost of Living Index (TCLI), welfare is a function derived from the expenditure function. The problem is finding the TCLI. Economists use traditional price indexes as proxies of the TCLI: the Paasche index gives an approximation for the MMU (Deaton and Zaidi, 2002): the Laspeyres index gives a welfare ratio (WR) (Blackorby and Donaldson, 1987). In this study, we follow the strategy proposed by Guren et al. (2021) and Nakamura *et al.* (2020), adjusting the PSA average household expenditure by the *SCOL* presented in the previous section.

We adjusted the household consumption levels of all PSA belonging to a state by the state`s $\exp(\hat{\lambda}_k)$ presented in Section 3. We calculate the adjusted household expenditure for each PSA using the respective state`s SCO. For each PSA, we calculate the following expression:

$$Expenditure_{sk}^{adjusted} = \frac{Expenditure_{sk}^{nominal}}{SCOL_k} \quad \textbf{(3)}$$

where $Expenditure_{sk}^{nominal}$ stands for the per capita unadjusted household expenditure of the PSA *s* belonging to state *k*, and $Expenditure_{sk}^{adjusted}$ stands for the adjusted per capita levels. Expression (3) is the welfare measure for each PSA used in this study.

4.1 Stochastic Dominance and Sensitivity Analysis

For welfare comparisons across regions, we use the Percentile 35 poverty line defined by Oliveira et al. (2016), based on data from the Brazilian Household Expenditure Survey - 2008-2009 (POF-IBGE), which is equivalent to the one used in this study. The authors argue that around the expenditure level equivalent to the 35th percentile of the per capita household expenditure distribution, families oscillate around the threshold of absolute poverty. This criterion places families whose income levels do not reach the desired minimum consumption level and individuals in a situation of transitory poverty caused by exogenous events, such as unemployment, the birth of a new dependent, the death of relative, or natural disasters, for example, under the poverty line.

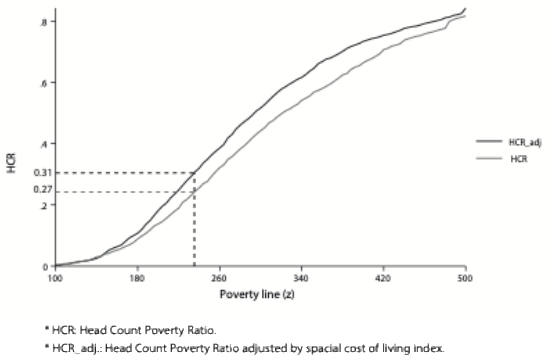
Thus, we consider PSAs with per capita consumption expenditure below the 35th percentile as poor and implement sensitivity analyses changing the poverty line, as in Deaton and Zaidi (2002). Let the per capita nominal expenditure levels across PSAs be represented by (x_1) and the adjusted levels distribution, controlling for cost of living differences, by x_2, and $F_1(x)\ and\ F_2(x)$ the cumulative distribution functions (CDF) of x_1 and x_2. $F_2(x)$ presents first order stochastic dominance (*FOD*) over $F_1(x)$ if and only if $F_2(x) > F_1(x)$ for all x. Let z represent the poverty line of distribution *x*, and *F(x)* its *CDF*. The proportion of poor PSAs, or PSAs headcount poverty rate (*HCR*), of such a distribution is *F(z)*, and the HCR_1 is $F_1(z)$ of x_1, and the HCR_2 is $F_2(z)$ of x_2 (Deaton and Zaidi, 2002).

Figure 3 displays the results, with F(z) in the horizontal axes and the share of poor PSAs in the vertical axis.The vertical distance between $F_1(z)$ and $F_2(z)$ describes the differences in the HCR of the distributions. For example, for a given poverty line z*, if $F_2(z^*) - F_1(z^*) = 0.40 - 0.30 = 010$, we conclude that adjusting for SCOL differences increased the share of poor PSAs in 10 percentage points, from 30% to 40%. The distance between the lines at point z* indicates how the estimated HCR is sensible to the purchasing power of the PSA, given by geographical price differences. For any specific poverty line, if the CDF of $F_2(z)$ lies above the CDF of $F_1(z)$, then $F_2(z) - F_1(z) > 0$ for all z. In this case, the poor's PSAs welfare is lower when measured by x_2 compared to x_1, regardless of the point chosen.

Figure 3 presents the estimated *F(z)*. The poverty lines in the horizontal axis are expressed in monetary per capita values, with BRL 223,00 corresponding to the 35% percentile. At this point, adjusting for SCOL levels increases the share of poor PSAs from 27% to 31%. Figure 4 presents the differences between the lines and the confidence intervals produced by bootstrapping simulations. Figure 4A in the Appendix shows the same information for the PSAs located in the country's five macro-regions. For the North and Mid-West regions, there are no important differences between nominal and adjusted values. In the poor Northeast region, controlling for the SCOL reduces

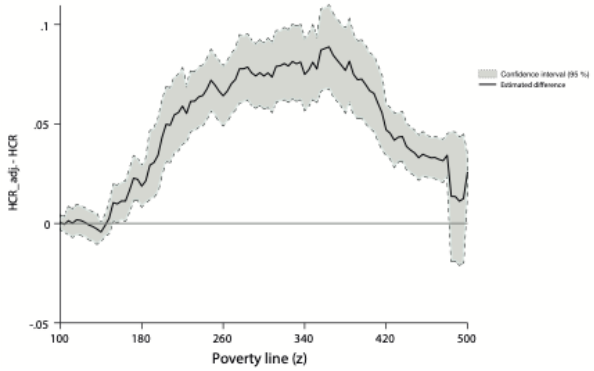
the share of poor PSAs, given their low SCOL levels, as presented in Section 2. On the other hand, for the richer and more expensive Southeast and South regions, controlling SCOL increases the share of poor PSAs.

Figure 3 – Head Count Poverty Ratios (HCR)



* HCR: Head Count Poverty Ratio.
* HCR_adj.: Head Count Poverty Ratio adjusted by spacial cost of living index.

Figure 4 – Differences in HCR



The format of the aggregate CDF conditions the results of the sensitivity analysis: the steeper the curve, the larger the changes in HCR in relation to small changes in the poverty line (Ravallion and Huppi, 1991). PSAs right above the line are vulnerable to changes in the poverty line (Ravallion, 2016; Foster et al., 2013). Therefore, it is essential to examine how the proportion of poor PSAs changes with slight variations in the poverty line. Table 5 shows some cases. If the poverty line is increased by 10%, from BRL 223,06 to BRL 245,37, adjusting for the SCOL provides larger differences between adjusted and unadjusted expenditure (from 3.1 pp in P35 to 4.0 pp). A similar 10% reduction in the poverty line value reduces the effect of price adjustments to 2 pp. Figure 4 indicates that for poverty lines between BRL 180 and BRL 490, the proportion of PSAs considered poor increases with the SCOL adjustment.

Table 5 – Sensitivity of the HCR to the poverty line

	Poverty line (P35)	HCR_adj	HCR	Change from HCR (%)
	BRL	(A)	(B)	(A)-(B)
10%	245.37	0.388	0.348	4.0
5%	234.21	0.348	0.309	3.8
P35	223.06	0.306	0.274	3.1
-5%	211.91	0.266	0.236	3.0
-10%	200.75	0.224	0.204	2.0

Figure 4 shows that the North region has the largest share of poor PSAs, particularly between around BRL 200 and BRL 420. The poor Northeast follows suit. The South and Mid-West are at the other extreme, with fewer PSAs considered poor. The Southeast takes an intermediate position.

Figure 4 – HCR by macro region

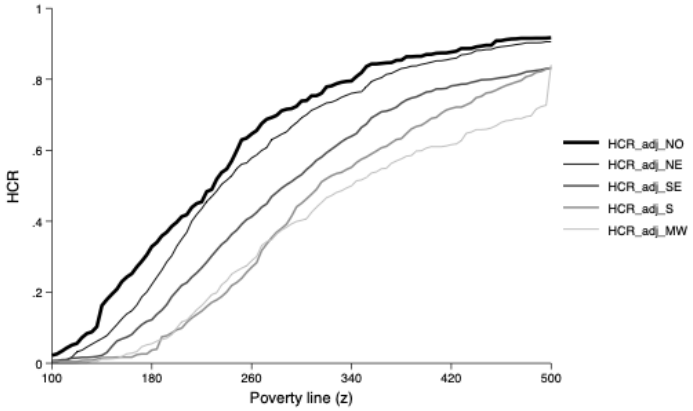


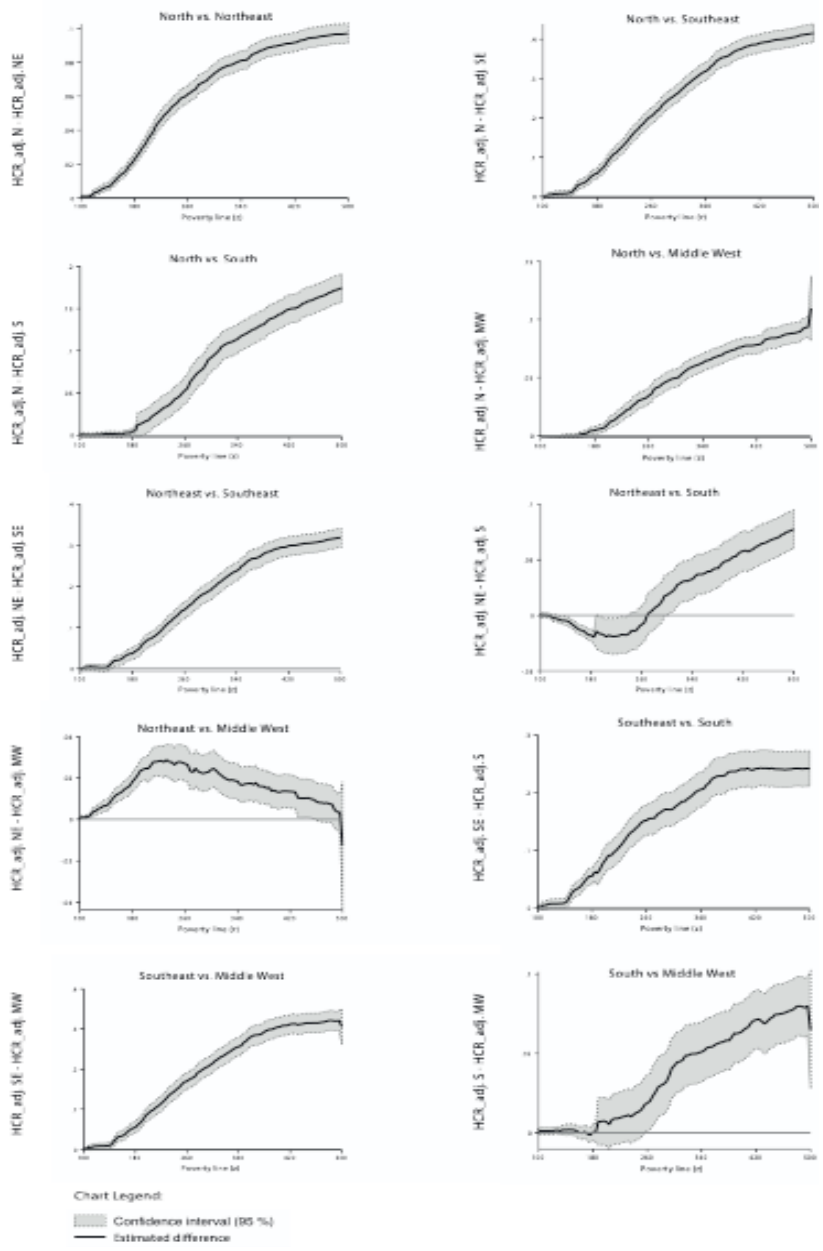
Table 6 illustrates how the adjusted poverty line influences the PSA´s HCR across macro-regions. The North region has the highest shares of poor PSAs for all poverty lines simulated; however, the effect of changing poverty lines is not as significant as in other cases. The South region, for example, with the lowest share of poor PSAs at P35, faces changes ranging from -64% to +30% for different poverty lines, making it the most sensitive to changes in the poverty line.

Table 6 - Sensitivity of the headcount poverty across macro regions

	Poverty Line	NO	Change from P35	NE	Change from P35	SE	Change from P35	SO	Change from P35	MW	Change from P35
10%	245.37	0.58	15.9%	0.55	14.9%	0.37	23.5%	0.22	30.5%	0.25	30.6%
5%	234.21	0.54	9.2%	0.51	8.1%	0.33	14.8%	0.18	15.5%	0.18	4.6%
P35	**223.06**	**0.49**	**0.0%**	**0.47**	**0.0%**	**0.28**	**0.0%**	**0.15**	**0.0%**	**0.17**	**0.0%**
-5%	211.91	0.45	-8.3%	0.42	-12.9%	0.24	-15.5%	0.13	-20.8%	0.13	-30.5%
-10%	200.75	0.41	-19.7%	0.35	-34.2%	0.20	-37.0%	0.09	-64.0%	0.11	-56.9%

The set of graphs in Figure 5 illustrates the differences in PSA´s HCR between pairs of macro-regions. Although the numbers in Table 6 suggested minor differences across macro-regions, the differences in poverty lines are relevant for most of the comparisons presented. The comparisons reveal significant welfare inequality among PSAs in different macro-regions, with the North and Northeast exhibiting the lowest welfare levels, in contrast to PSAs in the South and Midwest, which have higher welfare levels.

Figure 5 – HCR_adj Differences between regions and confidence interval



5 CONCLUDING REMARKS

This study advances the measurement of urban welfare in Brazil by introducing a Spatial Cost of Living Index (SCOL) using information at the within-city area level derived from detailed household expenditure data. By adjusting consumption-based welfare indicators for regional price differences, we provide a more accurate depiction of poverty and inequality across the country's urban landscape.

The results reveal significant variation in the cost of living across Brazilian states and metropolitan areas, which directly affects assessments of poverty. Notably, while the North and Northeast regions remain the poorest in absolute terms, adjusting for the cost of living reveals that poverty in the Southeast and South regions is more prevalent than the nominal figures suggest. This highlights the

vulnerability of certain within-city areas in wealthier regions, where higher living costs erode real consumption levels.

The analysis demonstrates that relying on nominal income or expenditure figures alone can misrepresent both the depth and geography of poverty. Incorporating spatial price variations into welfare analysis alters poverty headcount ratios and shifts our understanding of regional disparities. Sensitivity tests further confirm the robustness of the SCOL-adjusted estimates across a range of poverty thresholds.

Ultimately, this study underscores the importance of spatially nuanced policy tools. Targeted interventions should account not only for income levels but also for cost-of-living differences across and within cities. This approach enables more equitable and efficient poverty alleviation strategies in urban Brazil.

REFERENCES

ALMEIDA, A. N.; AZZONI, C. R. Mudanças nas estruturas de consumo e custo de vida comparativo nas Regiões Metropolitanas: 1996-2020. *ESTUDOS ECONÔMICOS*, v. 51, p. 529-563, 2021.

ALMEIDA, A. N.; AZZONI, C. R. Custo de vida comparativo das regiões metropolitanas brasileiras: 1996-2014. Estudos Econômicos, v. 46, p. 253-276, 2016.

AZZONI, C.R.; SEABRA, D. Custo comparativo de aluguéis para cidades e áreas de ponderação. Revista Brasileira de Estudos Regionais e Urbanos, 12 (2), 242-260.

AZZONI, C. R.; MENEZES, T.; CARMO, H. E. Comparações da Paridade do Poder de Compra Entre Cidades: Aspectos Metodológicos e Aplicação ao Caso Brasileiro. *Pesquisa e Planejamento Econômico* (Rio de Janeiro), Rio de Janeiro, v. 33, n.1, p. 91-126, 2003.

AZZONI, C. R.; CARMO, H. E.; MENEZES, T. Índice de custo de vida comparativo para as principais regiões metropolitanas brasileiras: 1981-1999. *Estudos Econômicos*. Instituto de Pesquisas Econômicas, São Paulo, v. 30, n.1, p. 1-2, 2000.

AZZONI, C. R.; CARMO, H. E.; MENEZES, T. A região Sudeste é mesmo mais rica ou apenas mais cara? Diferenças de custo de vida e desigualdade regional da renda real no Brasil. *Revista Econômica do Nordeste*, Fortaleza, v. 29, n. Especial, p. 479-1100, 1998.

AZZONI, C. R.; SEABRA, D. M. da S. Custo Comparativo de Aluguéis para Cidades e Áreas e Ponderação. **Revista Brasileira de Estudos Regionais e Urbanos**, *[S. l.]*, v. 12, n. 2, p. 242–260, 2018. Disponível em: https://revistaaber.org.br/rberu/article/view/322. Acesso em: 5 jul. 2025.

GUREN, A.; McKAY, A.; NAKAMURA, E. STEINSSON. What do we learn from cross-regional empirical estimates in macroeconomics? NBER Macroeconomics Annual 35 (1), 175-223. 2021.

CHEN, S.; RAVALLION, M. Data in transition: assessing rural living standards in Southern China. *China Economic Review*. vol. 7, issue 1, p. 23-56. 1996.

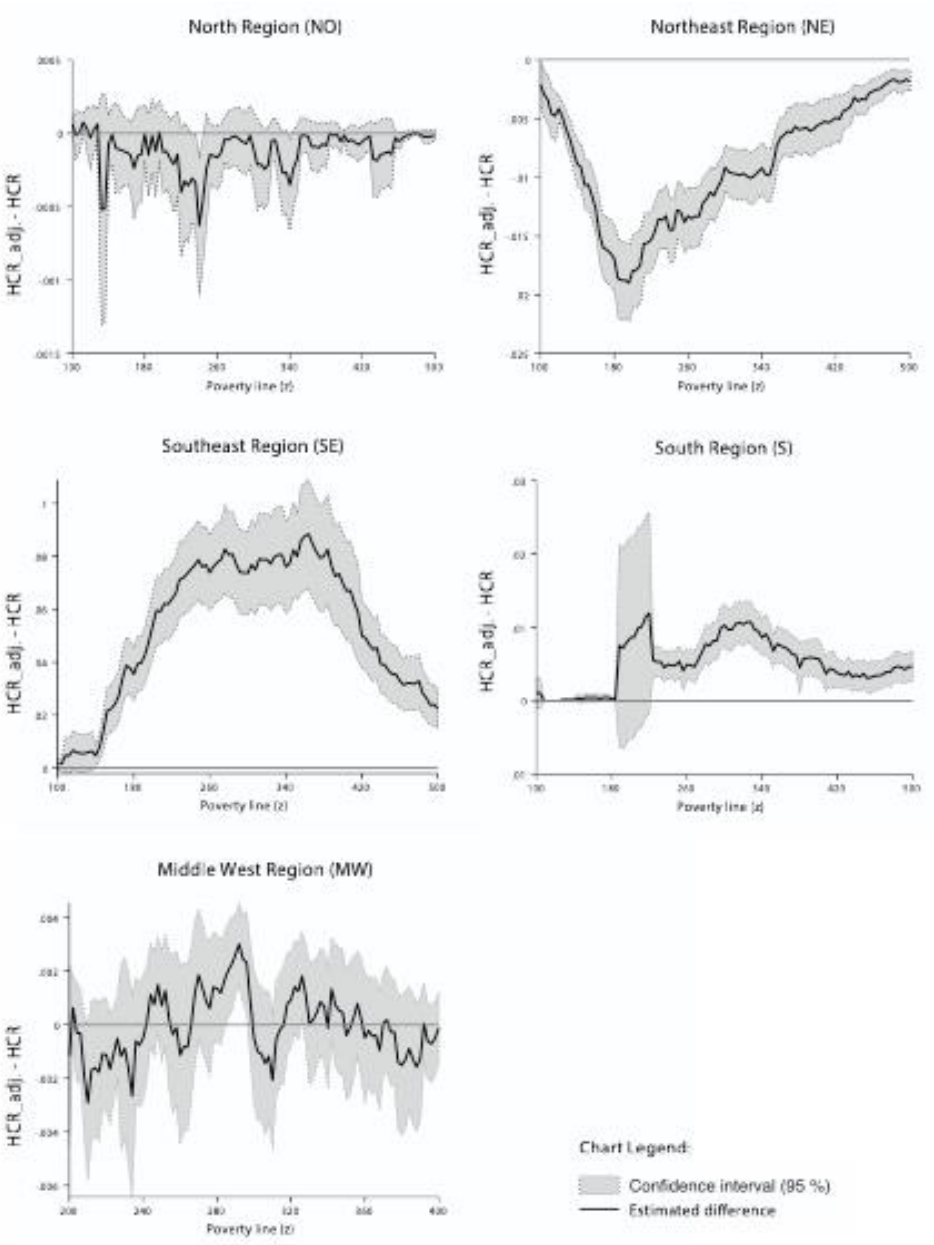
DEATON, A.; ZAIDI, S. *Guidelines for Constructing Consumption Aggregates for Welfare Analysis*. LSMS. 2002.

DEATON, A. The analysis of household surveys: a microeconometric approach to development policy. *World Bank Publications.* 1997.

DEATON, A. Quality, quantity, and spatial variation of price. *American Economic Review*. v.28, n.3. 1988.
GUREN, A.; McKAY, A.; NAKAMURA, E. STEINSSON. What do we learn from cross-regional empirical estimates in macroeconomics? NBER Macroeconomics Annual 35 (1), 175-223. 2021.
HELLIWELL, J.F. LAYARD, R. SACHS, J.D.; DE NEVE, J.E. AKNIN, L.B.; WANG, S. (Eds). World Happinness Report. University of Oxford: Wellbeing Research Centre. 2025.
MANCINI, G.; VECCHI, G. On the Construction of a Consumption Aggregate for Inequality and Poverty Analysis. The World Bank. 2022.
MENEZES, T.A.; AZZONI, C.R.; MOREIRA, G.R.C. Diferenças em Gastos com Aluguel entre Estados, Tipos de Área e Níveis de Renda Familiar no Brasil. *In*: Fernando G. Silveira, Luciana M. Servo, Tatiane Menezes e Sérgio F. Piola (Org.). Gasto e Consumo das Famílias Brasileiras Contemporâneas, Brasília, Chapter 9, p. 329-346. 2007.
MENEZES, Tatiane Almeida. *Custo de vida regional e convergência de renda per capita entre as regiões metropolitanas brasileiras*. Tese de Doutorado. FEA-USP. 1999.
RAVALLION, M. *Poverty Lines and Theory and Practice*. LSMS. 1998.
RAVALLION, M. Are the world's poorest being left behind? *Journal of Economic Growth*. Vol. 21. 2016.
SEABRA, D.; AZZONI, C. R. Custo comparativo de aluguéis para cidades e áreas de ponderação. *REVISTA BRASILEIRA DE ESTUDOS REGIONAIS E URBANOS*, v. 12, p. 242-260, 2018.
SELVANATHAN, E.A.; RAO, D.S. Prasada. Index Numbers: A Stochastic Approach. University of Michigan Press. 1994.
UNDP (United Nations Development Programme). 2025. Human Development Report 2025: A matter of choice: People and possibilities in the age of AI. New York.

APPENDIX

Figure 4A – HCR Differences by macro region


North Region (NO)
Northeast Region (NE)
Southeast Region (SE)
South Region (S)
Middle West Region (MW)
HCR_adj. - HCR
Poverty line (z)
Chart Legend:
Confidence interval (95 %)
Estimated difference