

Territorial disparities in organic food markets: Evidence from scanner data in Italy

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ARTICLE INFO

Keywords:

Organic food
Scanner data
Organic-conventional price differential
Hedonic pricing
Market structure
Sustainable consumption

ABSTRACT

Ensuring equitable access to sustainable diets remains a critical challenge for food systems. This study examines territorial inequalities in the Italian organic food market by leveraging nationally representative retail scanner data covering 103 provinces. Focusing on a set of key staple product categories (eggs, rice, flour, and yogurt) within the modern retail sector, we develop novel indicators of organic product availability and market diffusion and, applying hedonic price models, we estimate provincial-level organic-conventional price gaps, highlighting their implications for affordability. Results reveal marked North-South disparities: organic products are consistently more available and sold at lower price gaps in central and northern Italy than in southern regions, even after controlling for packaging and product characteristics. These findings suggest that territorial inequalities in organic food access are not only demand-driven but also structurally linked to retail market organisation. Beyond the Italian case, the proposed framework demonstrates the potential of scanner data for monitoring spatial disparities in sustainable food access and supporting evidence-based policies to promote a more inclusive transition toward sustainable consumption.

1. Introduction

The growing urgency of transitioning towards more sustainable food systems has positioned consumption patterns at the heart of contemporary environmental and socio-economic challenges [1], [2].

Food consumption alone accounts for nearly one-third of the ecological footprint of households, underscoring its pivotal role in shaping sustainable production and consumption pathways [3], [4]. In this context, organic food emerges as a key component of sustainable diets, offering not only environmental benefits but also social and ethical advantages related to health, safety, and producers' welfare [5]; [6].

Defined as food produced through organic farming methods that exclude synthetic inputs and genetically modified organisms (GMOs), organic food is increasingly perceived as a sustainable alternative to conventional options [7]. Its potential contribution to achieving Sustainable Development Goals (SDGs) - particularly those related to health, responsible consumption, and climate action - is widely acknowledged [8]; [9,10].

The European Commission's Farm to Fork Strategy (2020) recognises organic agriculture as instrumental in delivering the Green Deal's objectives. This policy momentum is supported by the EU Organic Action

Plan (2021-2027), which aims to expand both the supply and demand for organic products, fostering more resilient and circular food systems. Accordingly, the European organic food market reached over €45.1 billion in 2022, with significant contributions from Germany, France, and Italy [11].

Italy represents a dynamic setting for analysing organic food consumption. In 2023, its organic market reached €3.88 billion, a modest but steady increase from the previous year, according to the Italian Institute of Services for the Agricultural and Food Market (ISMEA, 2023). With 19% of its agricultural land under organic cultivation, Italy ranks among the EU leaders, ahead of the European average FiBL, 2022. Yet, despite strong production capacity, domestic consumption lags behind Northern European countries, accounting for only 3.5% of total food expenditure compared to over 11% in Denmark and Austria.

The modern retail sector has played a central role in shaping the Italian organic food market, with 58% of household organic purchases occurring through this channel and private-label products representing nearly half of total sales Osservatorio SANA - Nomisma, 2023. Large retailers contribute to enhancing product visibility, availability, and consumer trust in organic labels (Rana and Paul, 2020; [12,13]). At the same time, the uneven spatial distribution of modern retail outlets raises

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<https://doi.org/10.1016/j.seps.2026.102525>

Received 2 March 2026; Received in revised form 18 May 2026; Accepted 1 June 2026

Available online 3 June 2026

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concerns from a food access perspective, as limited local availability of organic products may create situations comparable to food deserts, in which households face structural barriers to accessing healthy and sustainable food options [14]. From a supply-side perspective, the breadth of organic food availability and assortment plays a critical role in enabling sustainable consumption practices [15,16]. Studies have shown that wider product ranges not only attract new consumers but also encourage occasional buyers to become habitual purchasers [17]. Conversely, limited assortments are cited among the primary barriers to consumption [18].

Nevertheless, economic barriers persist, with premium prices often deterring broader adoption [19]; [20]. The “price premium” reflects both real production costs and perceived added value, acting simultaneously as a signal of quality and a constraint on affordability [21,22]. In Italy, the magnitude of organic price premiums varies significantly across product categories and regions [23]; [24].

In addition to price, the size and format of product packaging play a critical role in shaping consumers’ purchasing decisions and perceptions of organic food [25]. Smaller package sizes—commonly associated with organic products—may signal higher quality, safety, and sustainability, while also reflecting retailers’ strategies to make premium-priced products more accessible in absolute terms [26]. From an environmental perspective, packaging decisions directly affect food waste and resource efficiency, making them a key component of sustainable consumption practices (Van Birgelen et al., 2009). As such, packaging characteristics represent not only a marketing tool, but also a structural element of sustainable food systems that deserves analytical attention in market assessments.

Despite the relevance of pricing dynamics for understanding consumption behaviours, research in the Italian context has predominantly relied on consumer surveys, which, while informative, fail to capture the complexity of real-world market interactions and spatial variability [27]; [28]. Only a few exceptions—focused on specific products or regions—have utilised scanner data to estimate price differentials or investigate attribute preferences [29,30]. This paper departs from the prevailing survey-based and regionally aggregated literature by showing that territorial inequalities in organic food affordability are not merely demand-driven but are structurally embedded in retail market organisation and local supply conditions.

To address this gap, the present study adopts a market-based approach, employing nationally representative retail scanner data to analyse the Italian organic food market through a detailed case study. The empirical analysis focuses on modern retail (hypermarkets and supermarkets), which constitutes the dominant distribution channel for organic food in Italy, accounting for an estimated 49–59% of total sales [18]. Empirically, the analysis focuses on a selected set of key staple product categories - eggs, rice, flour, and yogurt - considered representative of organic food consumption in the Italian context.

By jointly examining product availability, market diffusion, and organic–conventional price differentials for a set of key food categories, within a consistent analytical framework, this study contributes to the literature on sustainable consumption inequalities by demonstrating how retail infrastructures shape spatial opportunities and constraints. In doing so, it connects evidence from the organic food sector with broader debates on just transitions in food systems, where equitable access represents an essential condition for sustainability ([31]; Penne and Goedemé, 2021).

Importantly, the framework we propose is not confined to the Italian case. By integrating scanner data, hedonic price modelling, and territorial indicators, it provides a replicable tool to analyse spatial inequalities in organic food markets in other countries facing similar supply–demand mismatches, such as Spain, Greece, or parts of Eastern Europe.

Overall, the paper demonstrates that spatial inequalities in organic food access are fundamentally shaped by retail infrastructures and market organisation, rather than reflecting only consumer preferences

or income constraints.

Ultimately, our findings provide evidence-based insights to support retail practices, policy design, and consumer empowerment, thereby advancing the agenda of sustainable and equitable food systems in Europe. The remainder of this paper is organised as follows: Section 2 provides an overview of the Italian scanner data and outlines the estimation of the organic–conventional price differentials using the dummy hedonic regression method. Section 3 presents the results of the empirical analysis. Section 4 concludes by discussing key policy implications and directions for future research, with particular attention to strategies aimed at reducing territorial disparities and strengthening access to organic products within sustainable food systems.

2. Data and methods

2.1. Characteristics of Italian scanner data from large-scale retail trade

This study relies on scanner data from large-scale retail trade (hypermarkets and supermarkets), which constitute the primary distribution channel for organic food purchases in Italy. In 2023, organic food sales in modern distribution reached approximately €2.1 billion, accounting for about 58% of total household consumption, and showing an 8% increase compared to 2022 ISMEA, 2023. Earlier evidence also indicates that between 49% and 59% of organic food sales occur through modern retail channels, while a substantial share (27%–46%) is still attributed to traditional retailers and alternative outlets [32].

While scanner data from large-scale retail provide highly detailed, transaction-based information on prices, quantities, and product characteristics, they are inherently limited to purchases occurring within modern retail channels. As such, they do not capture alternative distribution systems such as farmers’ markets, short supply chains, specialised organic shops, or direct sales from producers. This represents a potential limitation, particularly in contexts where alternative channels play a significant role in food provisioning. If the spatial distribution of these channels differs systematically across regions, their exclusion may lead to an underestimation of organic product availability and may affect the measurement of price differentials.

However, given the central role of modern distribution in the Italian food system, scanner data still provide a robust and representative basis for analysing market dynamics and territorial disparities. They allow for a consistent and granular comparison of product availability, assortment, and pricing across provinces, based on actual transaction data rather than self-reported consumption [33].

Importantly, the diffusion of modern retail is not uniform across the Italian territory. Evidence suggests that large-scale retail chains have a stronger presence in Northern and Central regions, while in Southern regions their market share is relatively lower [34,35]. Correspondingly, consumers in Southern Italy tend to rely more frequently on traditional retail formats, open-air markets, and informal distribution channels [36]. These territorial differences in retail structure are directly relevant for the interpretation of our results, as they may reinforce spatial disparities in the observed availability and affordability of organic products within the modern retail system.

Italy, one of the European Union countries with the highest retail sales for organic food, represents an optimal context for studying sustainable food purchasing behaviour within a market-based framework.

The utilisation of data from large-scale retail trade is enabled through a collaborative effort between ISTAT and major hypermarket and supermarket chains, facilitated by A.C. Nielsen. ISTAT acquired scanner data from hypermarkets and supermarkets across all Italian provinces, encompassing turnover and quantities for each product, identified by the Global Trade Item Number (GTIN), an international standard product identification code, thus providing a comprehensive view of grocery products for a total of 79 product aggregates, belonging to five ECOICOP divisions (01, 02, 05, 09, 12).

The sample comprises approximately 1200 supermarkets and 500

hypermarkets, representing 55.4% of the total retail trade distribution for these products. Regarding the sampling methodology adopted for scanner data collection, outlets have been stratified on provinces (107), retail chains (16), and outlet types (hypermarket, supermarket), resulting in over 800 strata. Selection probabilities for each outlet were determined according to their turnover value.

The data obtained from the Italian large-scale retail sector is organised according to a market classification system based on the homogeneous product classification framework developed by the Efficient Consumer Response (ECR) community, an international initiative promoting standardisation in retail data with the assistance of the Nielsen company. The ECR taxonomy is structured in a hierarchical format, with product groupings becoming increasingly detailed as the taxonomy progresses. Each product category is associated with a reference document that delineates the criteria for inclusion and exclusion. To illustrate, within the yogurt product category, a potential market segment is identified as 'White - Whole Yogurt'.

In the present study, four product categories were considered: eggs, rice, flour, and yogurt. These categories were selected due to their prominence as organic food items consumed by Italian households ISMEA, 2023. The portion of the used dataset consists of 94,143 annual price quotes from the 103 Italian provinces, including 532 unique products for eggs, 1133 unique products for flour, 648 unique products for rice, and 2288 unique products for yogurt.

The unit price value for each product identified by GTIN is determined by dividing the turnover by the quantity sold within each province. The aforementioned calculation is performed through the application of a weighted summation of outlet sampling weights. These indicators are conceptually related to the literature on food access and retail geography, where availability, assortment, and market diffusion are considered key dimensions shaping access to food. In this framework, retailer coverage reflects physical access, product coverage captures the breadth of available choices, and market shares provide a proxy for the effective diffusion of organic consumption [16].

2.2. Analytical approaches followed for measuring market indicators of organic products

To assess the structure and performance of the organic food market at a territorial level, this study computes a set of market indicators that capture the availability, variety, and market diffusion of organic products across Italian provinces and product categories.

These indicators are conceptually grounded in the literature on food access and retail geography, where availability, assortment, and market diffusion are recognised as key dimensions shaping access to food [16, 37]. Within this framework, retailer coverage reflects physical access to organic products, product coverage captures the breadth of available choices, and market shares provide a proxy for the effective diffusion of organic consumption.

These indicators are intended to inform both market development strategies and food policy interventions aimed at promoting sustainable consumption. They are not conceived as outcome measures of consumer behaviour, but as structural descriptors of market inclusiveness and retail accessibility. In the following, the term coverage refers to the proportion of retailers or products that are organic, while market share refers to the proportion of sales accounted for by organic products, either in value or volume.

Specifically, for each product category k in each province j ($j=1,2, \dots, m$), four measures are employed. Market coverage is assessed in two dimensions: the share of retailers offering organic products and the share of distinct organic products available. In addition, two market share indicators are calculated: market share by volume, which represents the proportion of organic products sold in terms of physical quantity, and market share by turnover, which reflects the proportion of organic products in the total sales value. The retailer coverage index is given by:

$$C_{kj}^R = \frac{N_{kj}^{R,org}}{N_{kj}^{R,tot}} \cdot 100 \quad (1)$$

Where $N_{kj}^{R,org}$ is the number of outlets offering at least one organic product in category k in province j , and $N_{kj}^{R,tot}$ is the total number of outlets offering products (organic and conventional) in the same category and province. The second indicator, product coverage, is defined by:

$$C_{kj}^P = \frac{N_{kj}^{P,org}}{N_{kj}^{P,tot}} \cdot 100 \quad (2)$$

Where $N_{kj}^{P,org}$ is the number of distinct organic products (GTIN-level varieties) sold in category k in province j , and $N_{kj}^{P,tot}$ is the corresponding total number of distinct products (organic and conventional) in the same category and province. Market diffusion is further assessed through two share indicators. The market share by turnover is calculated as:

$$MS_{kj}^V = \frac{\sum_{i=1}^{n_{kj}} T_{ijk}^{org}}{\sum_{i=1}^{n_{kj}} T_{ijk}^{tot}} \cdot 100 \quad (3)$$

Where T_{ijk}^{org} denotes the turnover (in euros) of organic product i in category k and province j , while T_{ijk}^{tot} represents the total turnover (organic and conventional). Finally, the market share by volume is expressed as:

$$MS_{kj}^Q = \frac{\sum_{i=1}^{n_{kj}} Q_{ijk}^{org}}{\sum_{i=1}^{n_{kj}} Q_{ijk}^{tot}} \cdot 100 \quad (4)$$

Where Q_{ijk}^{org} is the quantity of organic product i sold in category k and province j , while Q_{ijk}^{tot} is the total quantity sold (organic and conventional). Volumes are expressed in kilograms (kg) for rice, flour and yogurt, and in units (pieces) for eggs. Volume-based shares provide a complementary perspective, abstracting from price differences.

Together, these indicators allow us to disentangle physical availability, assortment breadth, and the economic relevance of organic products across territories. These four measures provide complementary perspectives on the inclusiveness and structural maturity of the organic sector. Higher coverage and market share values indicate stronger diffusion of organic consumption patterns and better integration of sustainable options in local retail ecosystems.

2.3. The hedonic Provincial Product Dummy model to estimate price differential between organic and conventional products

To assess price differential between organic and conventional products, we focus mainly on two product attributes: production method and price. The production method has two levels: organic and conventional. The contribution of production methods on price has been estimated by using the hedonic Country Product Dummy (CPD) model (hereafter CPD), specified according to the analytical framework developed by Kokoski [38], Kokoski et al. [39] and Silver [40]. This model broadens the array of predictors by incorporating variables that encompass the qualitative attributes of each product (such as flavour, aesthetics, shelf life, and retail type).

The hedonic pricing method for organic products is basically a regression of the price of the product against known relevant determinants that affect the price. A hedonic equation is expressed as

Table 1

Number of observations, GTIN and markets in each product aggregate – All markets classification.

	N. of observations			N. of unique GTIN			N. of Markets
	Traditional	Organic	Total	Traditional	Organic	Total	
Eggs	2389 (83%)	485 (17%)	2874	465 (87%)	67 (13%)	532	3
Rice	9161 (92%)	765 (8%)	9926	578 (89%)	70 (11%)	648	14
Yogurt	61,541 (92%)	5254 (8%)	66,795	2052 (89%)	236 (11%)	2288	17
Flour	12,419 (85%)	2129 (15%)	14,548	923 (81%)	210 (19%)	1133	7

Source: Authors' elaborations from Italian Scanner data, 2018.

follows: $P = f(C; A, t)$ where P is the price, C are the characteristics of the product (e.g., production methods, design, brand, outlet type, etc.), A are area characteristics and t is an indicator of time. For the model specification we used the semi-log linear form. Other model specifications could be in principle used, such as the linear or double-logarithmic form [40]. The semi-log specification is preferred as it allows a straightforward interpretation of coefficients in percentage terms and ensures consistency with the CPD literature commonly used in price comparison studies.

The main advantages of this model specification are that: it enables easy interpretation of the estimated coefficients as the proportions of the price that are attributable to the respective characteristics; the independent variables can be broken down into more specific variables in order to allow greater flexibility to the model specification; it mitigates the statistical issue of heteroskedasticity and the log-linear configuration allows obtaining residuals that are approximately normally distributed.

The dummy variable hedonic method is similar to the CPD method developed by Summers [41], except that the model includes a detailed set of variables on quality characteristics. Heravi et al. [42] provided the first application of scanner data in this framework.

For $j=1,2, \dots, m$ areas (in our case provinces), $i=1,2, \dots, n$ items in a basic heading, p_{ij} represents the price of i -th item in j -th geographical area and ε_{ij} is the error term, the hedonic Provincial Product Dummy (HPPD) regression model, hereafter HPPD, is given by:

$$\ln p_{ij} = \beta_0 + \sum_{i=1}^n \beta_i Z_i + \sum_{j=1}^m \alpha_j D_j + \varepsilon_{ij} \quad (5)$$

Where D_j is a dummy variable equal to 1 for province j and 0 otherwise; Z_i is a vector of product k characteristics (e.g. organic vs non-organic products, branded vs private label ...), β_j are coefficients to be estimated, and ε is the error term.

Given that the scanner data provide quantities, sales and prices for each item in different areas, we used weighted least squares (WLS) regressions using expenditure shares in each geographical area as weights, following the approach suggested by Diewert [43].

Diewert [43] and Rao [44] have shown that the specific weights used

Table 2Package sizes for organic and traditional products - All markets classification.¹

Product category	Type	Mean	St.Dev.	T-Test Mt > Mo
Egg	Traditional	6.42	2.22	23.50***
	Organic	4.65	1.32	(0.000)
Rice	Traditional	850.01	369.75	35.95***
	Organic	575.69	181.98	(0.000)
Yogurt	Traditional	361.11	250.66	72.59***
	Organic	243.40	91.94	(0.000)
Flour	Traditional	740.98	584.17	16.64***
	Organic	603.24	295.67	(0.000)

Source: Authors' elaborations from Italian Scanner data, 2018.

¹ Package sizes expressed in kilograms (kg) for rice, flour, and yogurt; units (pieces) for eggs.

in WLS estimators for CPD parity estimates correspond to specific index number formulae. The weighted HPPD model can be expressed as:

$$\sqrt{w_{ij}} \ln p_{ij} = \beta_0 + \sum_{i=1}^n \beta_i \sqrt{w_{ij}} Z_i + \sum_{j=1}^m \alpha_j \sqrt{w_{ij}} D_j + \varepsilon_{ij} \quad (6)$$

w_{ij} is the expenditure share value of i -th item in the j -th province over the total number of items in the product category, which is computed as:

$$w_{ij} = \frac{p_{ij} q_{ij}}{\sum_{i=1}^n p_{ij} q_{ij}}$$

With $\sum w_{ij} = 1$ for each province and product category.

Given that in our analysis we are interested in the organic-conventional price gap across Italian provinces, it is essential to include in our HPPD model an interaction term with the geographical area variable (D_j) and the Z_i dummy characteristic concerning the production methods (the production method dummy variable $X_i \in Z_i$ dummy characteristics) as follows:

$$\sqrt{w_{ij}} \ln p_{ij} = \beta_0 + \sum_{i=1}^n \beta_i \sqrt{w_{ij}} Z_i + \sum_{j=1}^m \alpha_j \sqrt{w_{ij}} D_j + \sum_{i=1}^n \sum_{j=1}^m \delta_{ij}^* \sqrt{w_{ij}} D_j X_i + \varepsilon_{ij} \quad (7)$$

The antilogarithms of δ_{ij}^* are OLS estimates of the area-specific price parities for the two production methods with respect to the overall mean of the areas, thus we can obtain the price differential between organic and conventional products.

3. Results

This study analyses 94,143 price observations across 4601 unique products identified by GTIN code. To move beyond a purely descriptive analysis, the interpretation of results is structured around the underlying economic and market mechanisms that may explain the observed territorial differences, including retail infrastructure, supply-chain organisation, and local demand conditions. Table 1 summarises the number of price records, the number of distinct products by production method (organic vs. traditional), and the number of markets within each product category. A broad product and market coverage is observed, with yogurt representing the most represented category in terms of observations. Interestingly, the proportion of unique organic products is generally higher than the share of observations, except for the eggs category, suggesting that traditional products tend to be more widely available across retail outlets. This pattern may reflect differences in supply-chain organisation and retailer strategies, whereby conventional products benefit from broader distribution networks and greater economies of scale, leading to higher availability across outlets.

Given the influence of product package size on consumer behaviour [26], Table 2 compares packaging size distributions by production method. Across all product categories considered—eggs, rice, yogurt, and flour—traditional products consistently exhibit significantly larger package sizes than organic counterparts. Reported values refer to packaging size, expressed in kilograms (kg) for rice, flour, and yogurt, and in units (pieces) for eggs. T-test results confirm that these

Table 3
Unit prices for organic and traditional products - All markets classification.²

Product category	Type	Min	Mean	Max	St.Dev.
Egg	Traditional	0.11	0.29	1.07	0.08
	Organic	0.24	0.41	0.67	0.07
Rice	Traditional	0.73	3.27	14.40	1.88
	Organic	1.24	5.17	11.49	1.54
Yogurt	Traditional	0.36	4.67	24.11	1.92
	Organic	2.49	6.01	22.85	1.48
Flour	Traditional	0.29	4.88	115.59	8.38
	Organic	0.83	5.47	21.22	4.64

Source: Authors' elaborations from Italian Scanner data, 2018.

² Unit prices expressed in euros per kilogram (€/kg) for rice, flour, and yogurt; euros per piece (€/piece) for eggs.

differences are statistically significant ($p < 0.001$ in all categories). This finding may reflect a differentiation strategy associated with the organic segment, where smaller formats could signal higher quality, product selectivity, or reduced consumption footprint. From a market perspective, smaller package sizes may also reflect retailers' strategies to position organic products as premium goods while maintaining lower absolute price points, thereby partially mitigating affordability constraints despite higher unit prices.

Based on packaging size information, we computed unit prices (euros per kg for rice, flour, and yogurt; per piece for eggs). As reported in Table 3, organic products show consistently higher minimum, mean, and maximum prices compared to their traditional counterparts. Additionally, organic product prices exhibit lower standard deviations, suggesting less price dispersion. This stability may indicate stronger price positioning or tighter pricing policies within the organic segment. These pricing patterns may be associated with more standardised pricing strategies within the organic segment, as well as lower competitive pressure in markets where organic products are less widely available.

To improve comparability and reduce heterogeneity across product groups, the analysis was restricted to "core markets" for each product category. For example, the yogurt category excludes functional, drinkable, and Greek variants; for flour, non-cereal specialties and gluten-free mixes were excluded. In the egg category, liquid yolks were removed due to pricing incompatibility. These exclusions are justified by the substantially different pricing structures of the removed items, which could distort price-level assessments and variability.

As shown in Table 4, restricting the analysis to core markets

Table 4
Unit prices for organic and traditional products - Selected markets classification.³

Product category	Type	Min	Mean	Max	St.Dev.	N.
Egg	Traditional	0.11	0.29	1.07	0.08	2389
	Organic	0.24	0.41	0.67	0.07	485
Rice	Traditional	0.73	3.27	14.40	1.88	9161
	Organic	1.24	5.17	11.49	1.54	765
Yogurt	Traditional	0.36	3.73	24.11	1.85	25,561
	Organic	2.49	5.91	22.85	1.44	4480
Flour	Traditional	0.29	1.83	14.51	1.46	4363
	Organic	0.83	2.21	9.17	1.27	585

Source: Authors' elaborations from Italian Scanner data, 2018.

³ Unit prices expressed in euros per kilogram (€/kg) for rice, flour, and yogurt; euros per piece (€/piece) for eggs.

significantly reduces price dispersion in several categories, particularly flour. For yogurt, although the average price difference may seem modest, excluding high-priced traditional subcategories (e.g., functional drinks) lowers the mean price for traditional yogurt considerably. This adjustment ensures greater consistency in price comparisons across production methods by aligning product characteristics more closely.

Overall, the results highlight a clear and persistent organic-conventional price differential, together with smaller package sizes and more stable pricing patterns. These features suggest that organic products are positioned as premium yet streamlined options, potentially appealing to sustainability-oriented consumers. The lower price variability may also reflect stronger brand or retailer control within the organic segment. Building on these descriptive insights, the next section turns to market coverage and share indicators to assess the extent of territorial disparities in the diffusion of organic food across Italian provinces.

3.1. Results from market indicators

To complement the descriptive evidence on prices and packaging, this section presents a set of market indicators capturing the availability and diffusion of organic products across Italian provinces. In particular, the interpretation focuses on how differences in retail infrastructure and market organisation translate into heterogeneous levels of availability, variety, and diffusion of organic products across territories. As outlined in Section 2, these include coverage indicators - measuring both the presence of retailers offering organic products and the breadth of product assortments - as well as market share indicators, based on sales turnover and purchase volumes.

Fig. 1 presents the retail coverage indicator, calculated using formula (1), standardised by the number of retailers per 100,000 inhabitants.⁴ This density-based measure reveals a clear geographical divide, with central and northern Italian provinces showing higher availability of organic retail outlets relative to population levels across all product categories. These areas appear structurally better equipped to support organic food consumption from a supply-side perspective. This pattern likely reflects a higher penetration of large-scale retail chains and more developed distribution networks in these areas, which facilitate the inclusion of organic products within retail assortments.

While physical access through retail outlets is a prerequisite for food availability, it may not be sufficient to ensure meaningful consumer choice. The variety of organic products available is equally relevant in supporting sustainable and healthy diets [45]. Fig. 2 displays the coverage indicator by product variety, computed using formula (2). The geographic patterns differ across product categories: central provinces exhibit a broader assortment of organic yogurts, while northern and central areas lead in variety of organic eggs. Interestingly, southern provinces such as northern Sicily and Apulia show relatively higher availability of organic rice and flour, respectively.

A clear North-South gradient emerges from the joint interpretation of the two coverage indicators. Figs. 1 and 2 show that provinces in central and northern Italy are characterised by both a higher density of retailers offering organic products and a broader assortment of organic varieties, while many southern provinces display systematically lower

⁴ Resident population were obtained from ISTAT demographic statistics (resident population on 1 January 2018 at the provincial level), ensuring full temporal consistency with the scanner data, which also refer to 2018.

⁵ This figure shows the density of retailers offering at least one organic product, standardised per 100,000 inhabitants. Darker areas indicate higher retail availability of organic products, reflecting stronger physical access to sustainable food options.

⁶ This figure reports the share of distinct organic products relative to the total number of products within each category. Higher values indicate greater product variety and wider consumer choice in organic food offerings.

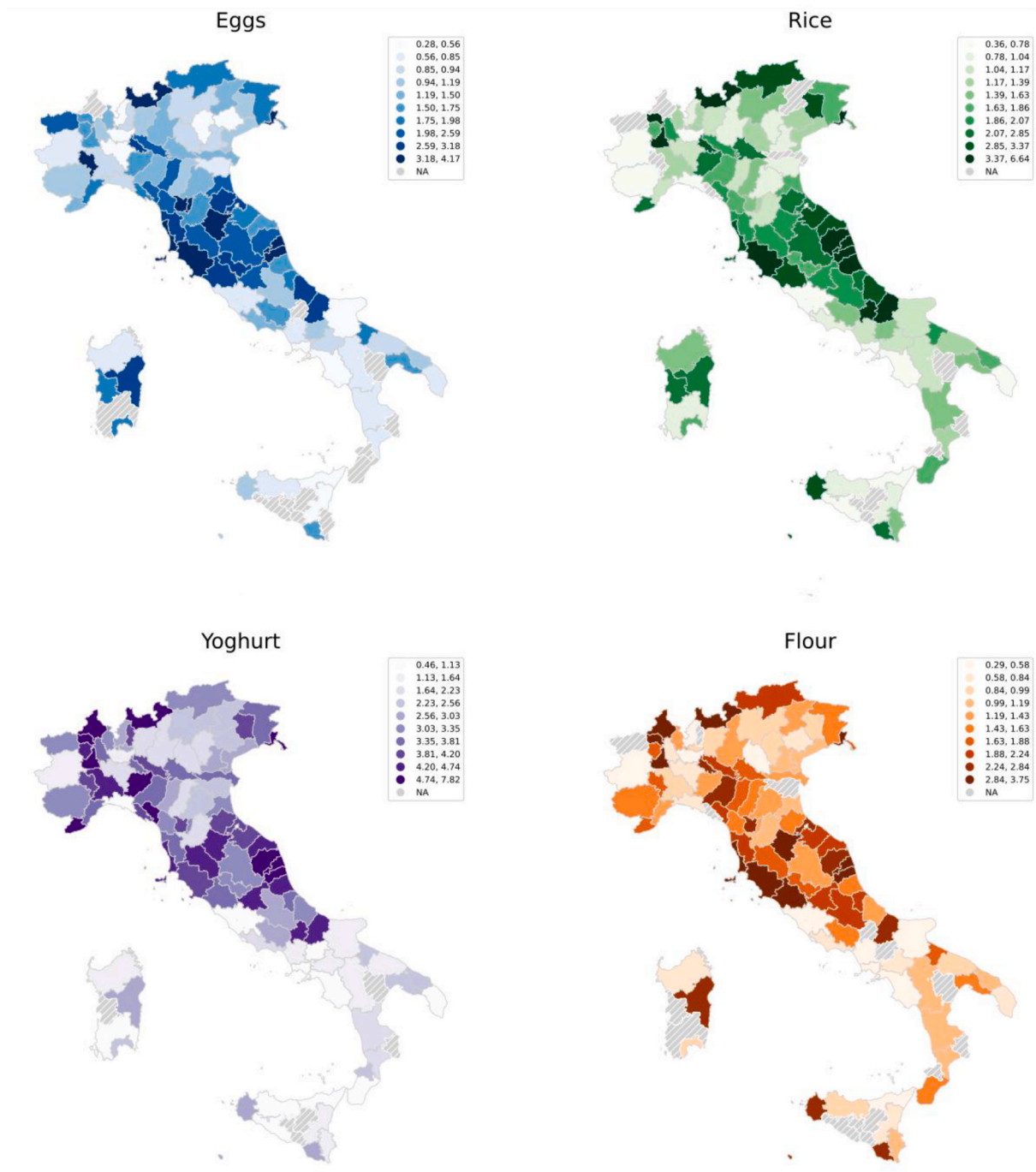


Fig. 1. Geographical distribution of organic retail coverage across Italian provinces.⁵

Source: Authors' elaborations from Scanner Data. Indicator expressed as number of retailers offering organic products per 100,000 inhabitants.

levels of retail coverage and, in several cases, more limited product diversity. This combination of reduced outlet availability and constrained choice suggests the presence of structural barriers to access that go beyond individual preferences or purchasing power.

From a food access perspective, these patterns are consistent with the notion of food desert-like conditions, whereby households face limited opportunities to access healthy and sustainable food options due to the uneven spatial distribution of retail infrastructure rather than to demand-side factors alone [46,47]. In the Italian context, such

conditions appear to be more prevalent in parts of the South, where lower retailer density and narrower assortments may jointly restrict access to organic food, even when some product categories show relatively higher availability. These findings indicate that territorial inequalities in organic food access are closely linked to long-standing regional disparities in retail development and market organisation. As a result, policies aimed at promoting sustainable consumption should explicitly account for spatial differences in retail coverage and assortment, as improving affordability or consumer awareness alone may be

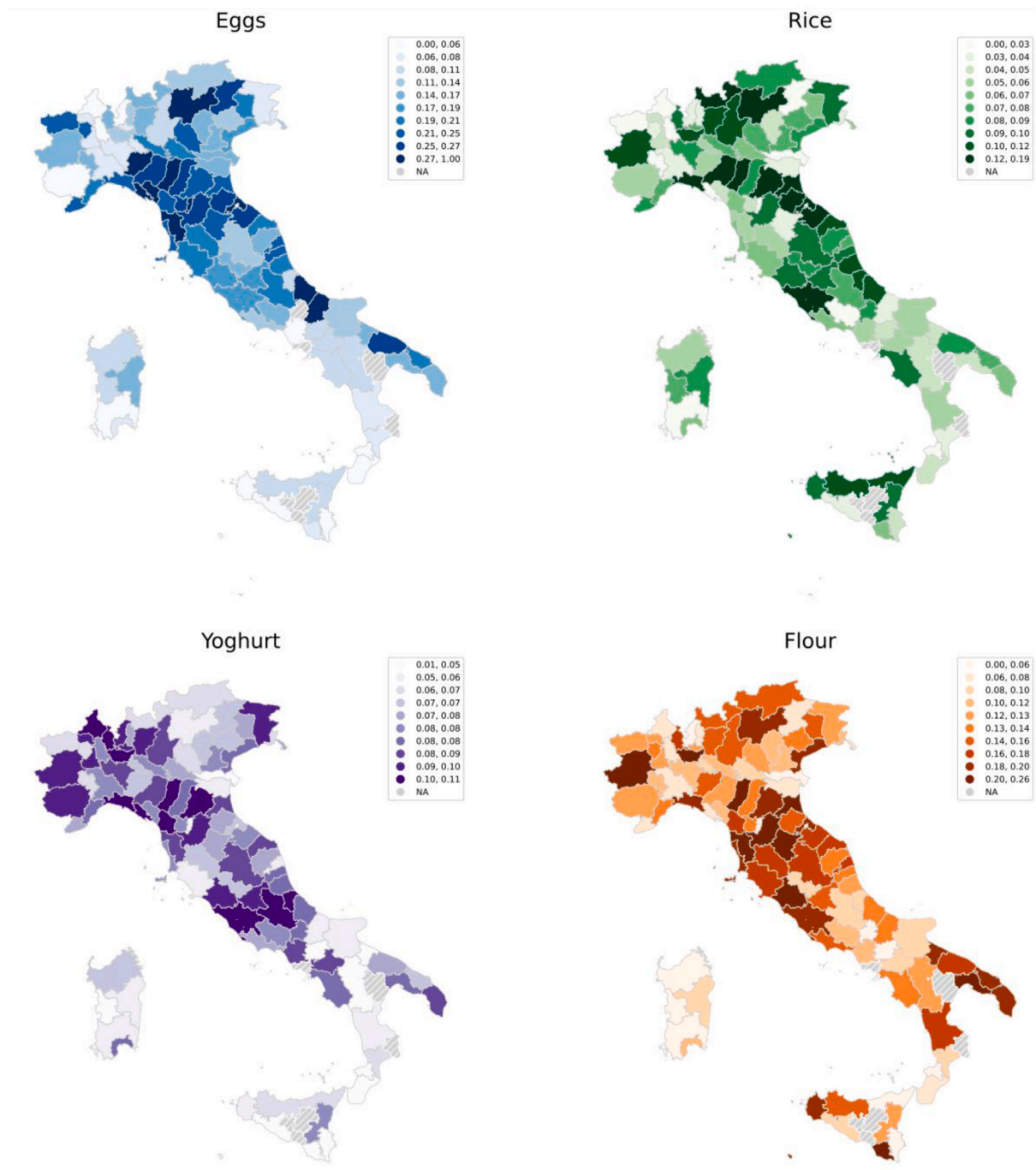


Fig. 2. Spatial variation in organic product assortment across Italian provinces.⁶

Source: Authors' elaboration from Scanner Data. Indicator expressed as share of distinct organic products over the total number of products in the same category.

insufficient in areas where physical access to organic food remains limited.

Figs. 3 and 4 report the market share indicators, respectively based on turnover and volume of organic sales. Although the two indicators

⁷ This figure presents the share of total sales value accounted for by organic products across Italian provinces. Higher values indicate stronger market penetration of organic products in terms of expenditure.

⁸ This figure shows the share of total quantities sold (in kilograms or units) accounted for by organic products. Compared to turnover-based measures, this indicator highlights differences in consumption patterns independently of price effects.

tend to show similar geographical patterns, their comparison highlights some regional discrepancies. In many southern provinces, both the turnover and volume shares of organic products remain noticeably lower than the levels of product availability. This may suggest that economic, cultural, or behavioural factors constrain organic consumption, even where supply-side conditions are improving.

A spatially differentiated pattern emerges clearly: provinces such as those in Tuscany, northern Lazio, and Trentino-Alto Adige consistently exhibit higher market shares for organic products, both in value and quantity. In contrast, most southern provinces lag behind—except for notable cases such as the province of Lecce, which stands out for its relatively high organic sales in both dimensions.

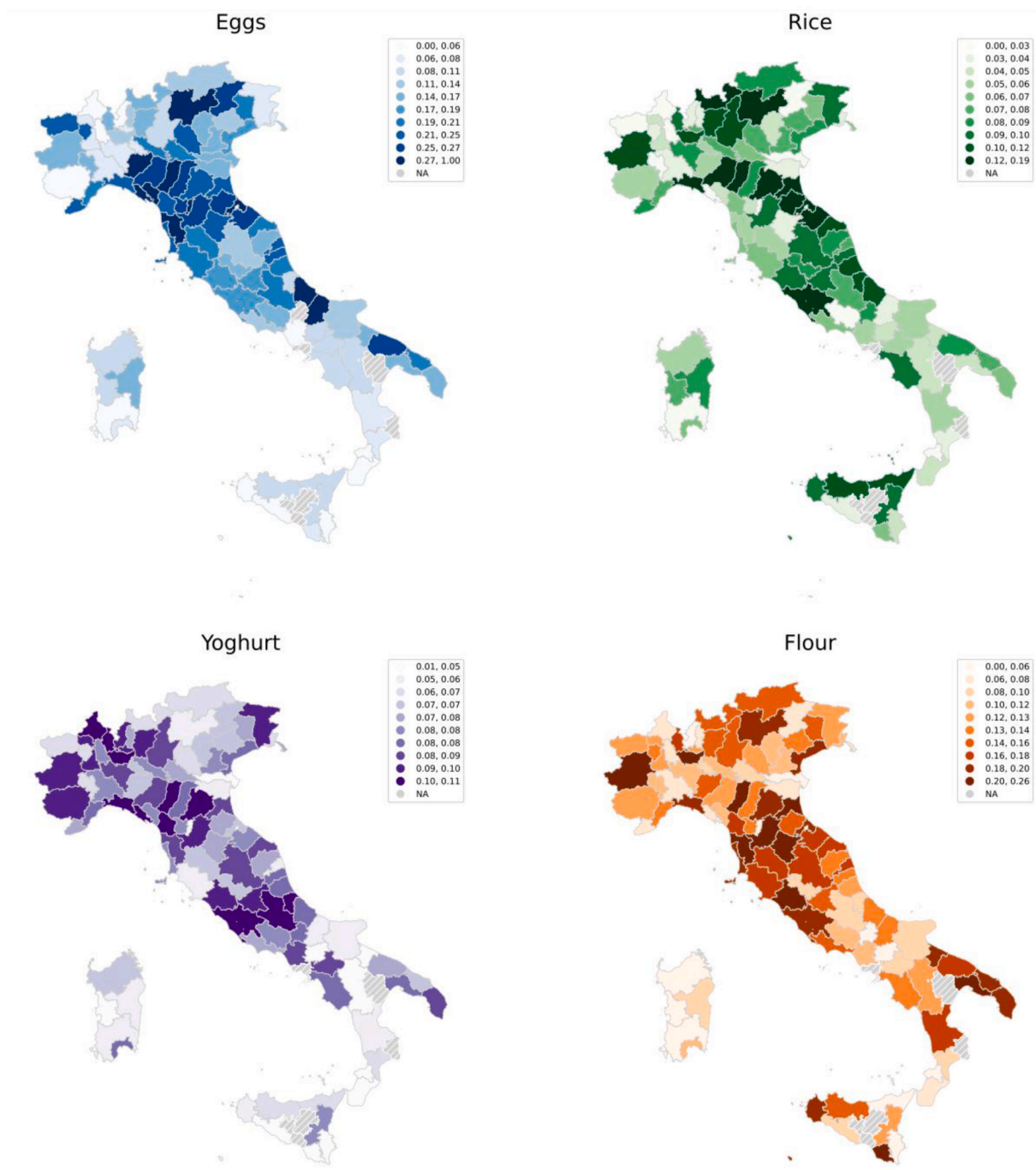


Fig. 3. Geographical distribution of organic market shares by turnover.⁷

Source: Authors' elaboration from Scanner Data. Market share expressed as percentage of total sales value accounted for by organic products.

These results underline the territorial inequalities in access and adoption of organic food in Italy, suggesting that interventions promoting more equitable food environments are essential to mainstream sustainable consumption. Overall, the joint analysis of coverage and market share indicators highlights how differences in retail infrastructure, supply-chain efficiency, and local market conditions jointly shape the diffusion of organic products across territories. To further investigate these disparities, the next section applies hedonic regression models (HPPD) to quantify organic-conventional price differentials across provinces.

3.2. Results from hedonic province product dummy models

In this section, we present results obtained from HPPD models, calculated using [formula \(6\)](#), for the prices of yogurt, rice, eggs and flour. The aim is to identify the price differential between organic and conventional products. To establish a baseline for our study, we first applied HPPD models to all markets within our product categories ([Table 6](#)) and then excluded the non-core markets for yogurt and flour ([Table 7](#)). For yogurt, the core market excludes functional, drinkable, and Greek variants; for flour, non-cereal specialities and gluten-free mixes were excluded. In the egg category, liquid yolks were removed due to pricing incompatibility. These exclusions were applied to reduce heterogeneity and ensure greater comparability across product groups.

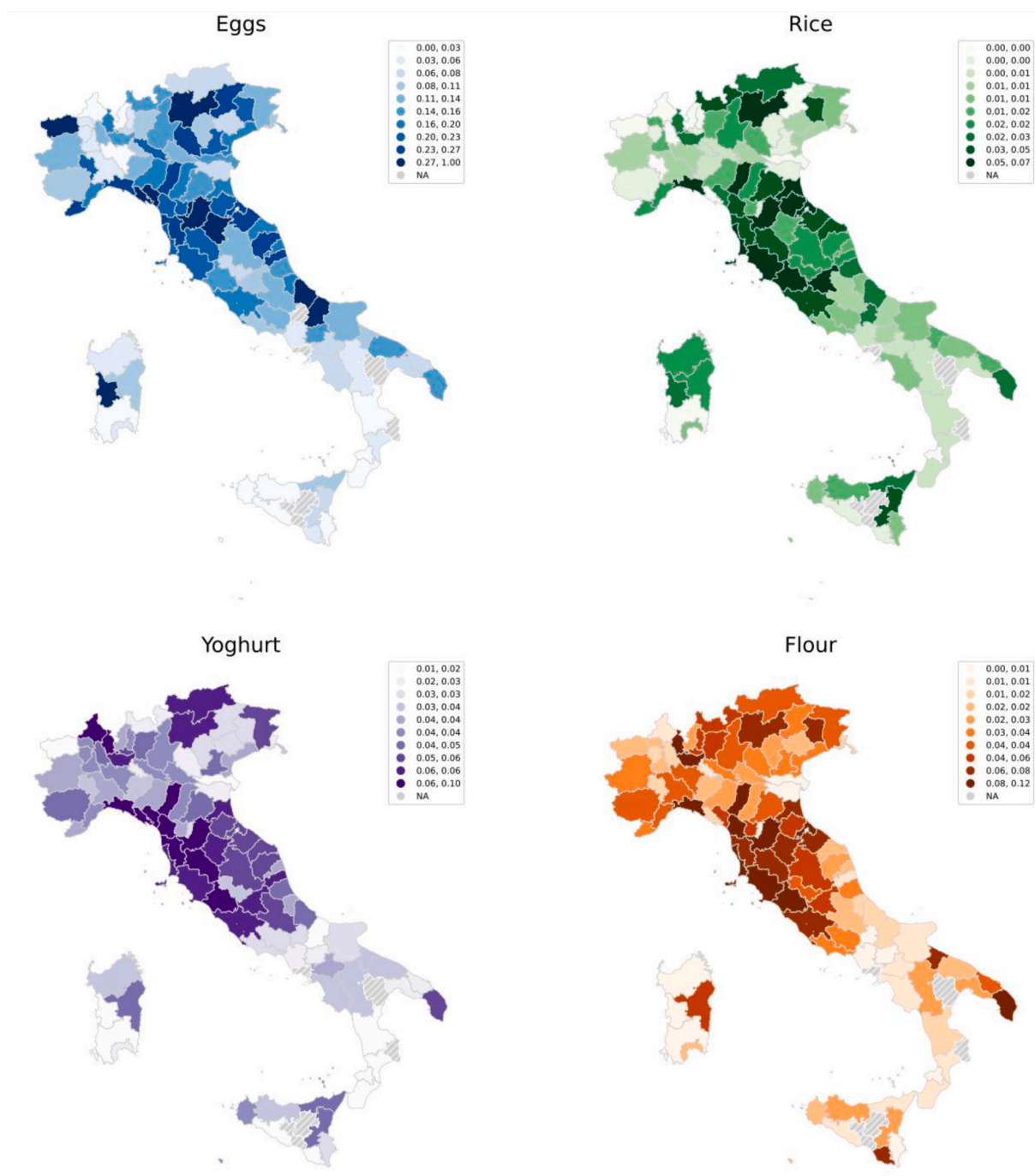


Fig. 4. Geographical distribution of organic market shares by volume.⁸

Source: Authors' elaboration from Scanner Data. Market share expressed as percentage of total sales volume (kg or pieces) accounted for by organic products.

Table 6
Results from HPPD models (all markets) – without province interaction.

	Eggs	Rice	Yogurt	Flour
Organic	41.03 (0.035)***	57.97 (0.125)***	–10.73 (0.172)	10.86 (0.054)
Provinces	yes	yes	yes	yes
Products charact.	Yes	yes	yes	yes
n.obs	2.874	9.926	66.795	14.548
Reset test	1.19	0.09	56.50***	6.16**
BP-test	1.22	1.02	5.35***	2.01***

Source: Authors' elaborations from Italian Scanner data, 2018.

Table 7
Results from Hedonic model for selected markets - without province interaction.

	Eggs	Rice	Yogurt	Flour
Organic	41.03 (0.035)***	57.97 (0.125)***	62.97 (0.017)***	77.36 (0.031)***
Provinces	yes	yes	yes	yes
Products charact.	yes	yes	yes	yes
N.obs	2.874	9.926	30.041	4.948
Reset - test	1.19	0.09	1.24	0.43
BP test	1.22	1.02	1.37	1.24

Source: Authors' elaborations from Italian Scanner data.

Table 6 reports the estimates from the HPPD models. Reported coefficients (β) refer to the log-price specification, with robust standard errors clustered at the province level shown in parentheses. The price differential between organic and conventional products is presented as a percentage, computed as $(e^\beta - 1) \times 100$. Model fit statistics (AIC and BIC) are reported for comparability across specifications.

Table 6 indicates that the coefficients for yogurt and flour are not statistically significant. For yogurt, the negative sign of the coefficient points to a counterintuitive result, suggesting a potential discount for organic products in this category. In the semi-log specification, coefficients expressed as $(e^\beta - 1) \times 100$ represent the percentage price differential between organic and conventional products. The estimates show that this differential is substantial for eggs and rice, amounting to approximately 41% and 58%, respectively. We can also note that the Regression Specification error test (RESET) rejects the null hypothesis of correct specification for our regression functions [48] in both categories, and the Breusch-Pagan test rejects the null hypothesis of homoskedasticity for the regression residuals [49]. Model fit was assessed using standard information criteria (AIC and BIC), which confirmed the robustness of the specifications. These findings motivated the refinement of product selection for two categories where the initial estimates appeared inconsistent. After excluding non-core product variants, the HPPD models reported in Table 7 yield statistically significant coefficients with the expected sign. The estimates are based on the log-price specification, with robust standard errors clustered at the province level (reported in parentheses). The corresponding organic-conventional price differentials, expressed as $(e^\beta - 1) \times 100$, amount to 63% for yogurt and 77% for flour, confirming more plausible and consistent results once heterogeneous product types are excluded. These results, more in line with observable reality and previous studies [50], reinforce the validity of selecting more homogeneous product aggregates before running a regression analysis. Results from RESET tests fail to find evidence of functional misspecification, and the Breusch-Pagan tests fail to find evidence of heteroskedasticity in our regressions' residuals. This reassures us on the soundness of our findings. These differences across product categories may reflect heterogeneity in production structures, supply-chain organisation, and market competition, which influence the extent to which organic products command price premiums.

Finally, the HPPD models estimated using formula (7) allow us to examine province-specific price differentials between organic and conventional products. The results, summarised in Fig. 5, reveal heterogeneous spatial patterns, with substantial variation in the magnitude of these differentials across provinces and product categories. Table 8 further shows that in a large number of provinces the estimated coefficients are statistically significant, providing robust evidence of marked regional disparities in organic-conventional price differentials.

Significant price differentials between organic and conventional for egg products are observed in Sicily, western Piedmont, and Valle d'Aosta regions. However, in a small number of provinces, there appears to be a possible discount for organic products, although these findings lack statistical significance and may be influenced by the relatively low availability of organic options in those areas. For rice, spatial variation is less pronounced, with the largest organic-conventional price differentials observed in provinces such as Sondrio in the North and Ragusa in the South. For yogurt, higher differentials emerge in Emilia-Romagna, Umbria, and Campania, while Tuscany, Trentino-Alto Adige, and Sicily record the lowest values. In the case of flour, the differential reaches its highest levels in North-West Italy. A few negative coefficients were also observed for flour (Mantua) and eggs (Oristano, Rovigo, and

Salerno), although these estimates were not statistically significant.

These territorial variations in price differential may also reflect underlying structural characteristics of regional food systems. First, although EU organic regulations are uniform across Italy, differences in certification practices, additional voluntary quality schemes, and the costs imposed by private control bodies can increase compliance costs, thereby contributing to wider affordability gaps. The Italian organic certification system-based on accredited private control bodies supervised at the national level-imposes administrative and economic burdens that may vary across regions, with potential consequences for both producers and final consumers [51].

Second, disparities in supply-chain configuration and logistics are equally relevant. Regions organised around strong agri-food districts and short food supply chains (e.g., Emilia-Romagna, Piedmont) tend to benefit from greater logistical efficiency and local coordination, which can help contain affordability gaps. In contrast, areas more dependent on external supplies may face higher distribution costs, translating into larger price differentials [52,53]. These factors suggest that institutional and structural conditions, beyond consumer demand alone, play a significant role in shaping regional disparities in the affordability of organic food. These structural mechanisms can be observed in practice when looking at specific regions where affordability gaps are particularly pronounced.

The relatively high organic-conventional price differential for eggs in Sicily may reflect underlying structural and market-specific dynamics. First, smaller-scale production and fragmented organic egg supply chains limit economies of scale, driving up unit costs. These findings have direct policy implications, as they suggest that reducing organic price premiums in these areas would require interventions targeting supply-chain efficiency, retail competition, and local market development rather than demand-side measures alone. This is compounded by greater reliance on external supplies, increasing transport and logistics costs Sinab, 2020. Second, limited availability of modern retail formats and discount retailers in Sicily reduces competition, allowing organic eggs to be positioned as higher-priced niche items. Together with potential certification costs in areas with few organic producers, these factors suggest that higher logistical burdens and premium positioning-rather than regulatory differences-explain the elevated organic egg prices in Sicily.

Similarly, the pronounced organic-conventional price differential for yogurt in Umbria may reflect limited economies of scale in local production, resulting in greater reliance on distant supply sources and higher logistical costs. If modern retail diffusion is lower relative to other regions, this could reduce competition and keep organic yogurt prices elevated. Moreover, consumer preferences for ethical attributes-such as eco-friendly packaging-have been shown to increase willingness to pay for organic eggs in other parts of Italy [54], a tendency that may extend to dairy products including yogurt. These examples illustrate how regional disparities in supply-chain structures, retail competition, and consumer preferences can translate into heterogeneous affordability gaps across provinces, even under a harmonised regulatory framework. Furthermore, we tested each pair of δ_{ij} coefficients with an F-test to assess whether statistically significant differences in the organic-conventional price differentials exist across provinces. As reported in Table 9, this is frequently the case for eggs and yogurt. These results corroborate the evidence of substantial inter-provincial heterogeneity in organic-conventional price differentials.

Overall, the evidence suggests that territorial differences in organic-conventional price differentials are closely linked to structural characteristics of local food systems, including supply-chain organisation, retail competition, and market accessibility, rather than being solely driven by consumer preferences.

4. Conclusions and policy implications

The growing demand for organic food reflects rising consumer

⁹ This figure displays province-level estimates of organic-conventional price differentials derived from HPPD models. Darker areas indicate higher price premiums for organic products, reflecting stronger affordability constraints. Estimates are based on selected market specifications.

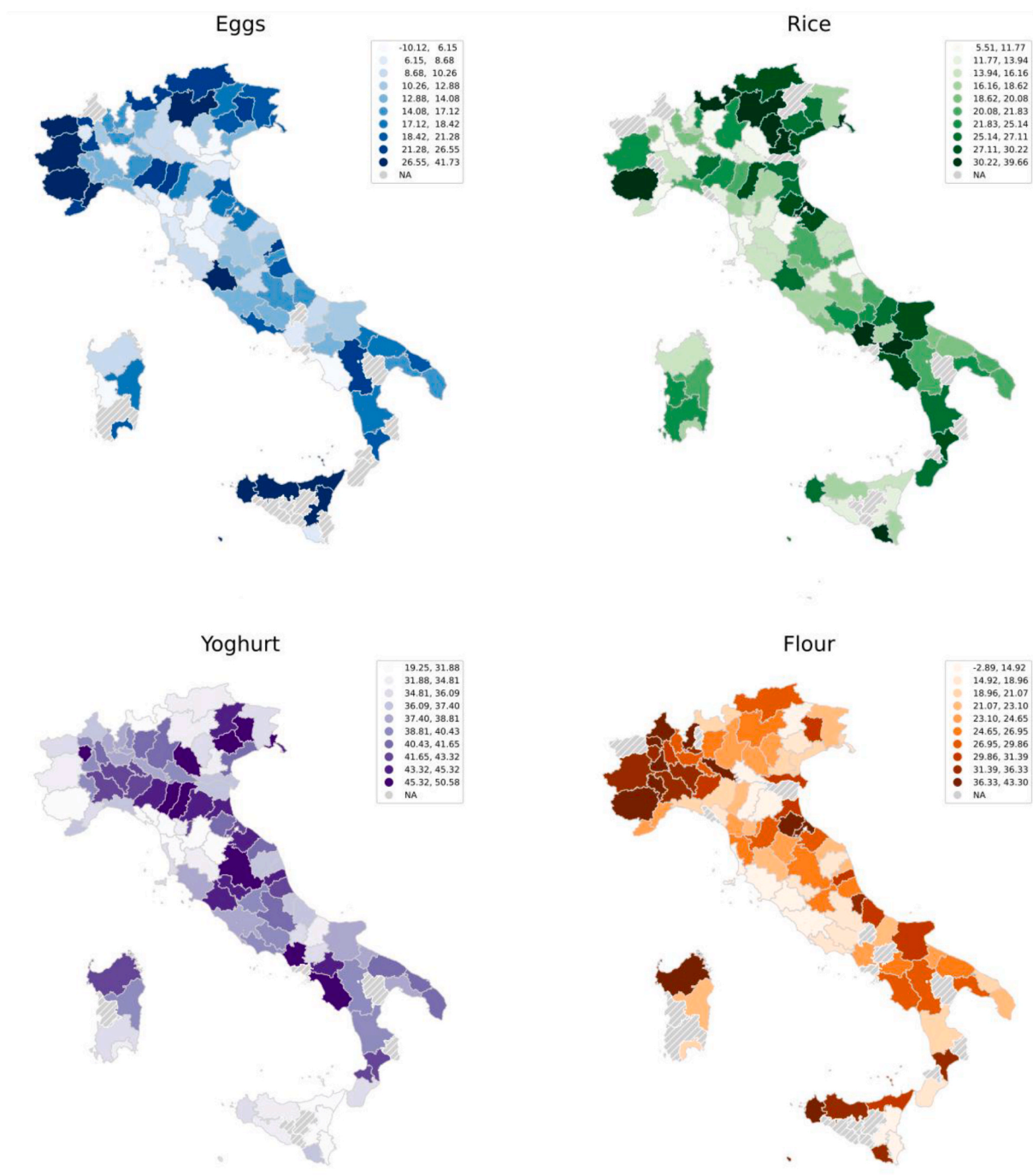


Fig. 5. Spatial heterogeneity in organic-conventional price differentials across Italian provinces.⁹

Source: Authors' elaborations from Italian Scanner data.

Table 8

Results from HPPD models for selected markets - province interaction.

	Eggs	Rice	Yoghurt	Flour
Organic*Provinces	yes	yes	yes	yes
N. significant Organic*Provinces coefficients/Total	60/96	35/96	102/102	74/93
Products charact	yes	yes	yes	yes
N.obs	2874	9926	30041	4948
Reset - test	0.37	1.44	0.56	0.37
BP test	1.32	1.21	0.54	1.08*

Source: Authors' elaborations from Italian Scanner data.

Table 9

HPPD results (selected markets) with province interaction – Statistical tests of inter-provincial differences in organic affordability gaps.

	Eggs	Flour	Rice	Yoghurt
Pairs of province coefficients significantly different at 5%	637/4560	140/4278	30/4560	1874/5151

Source: Authors' elaborations from Italian Scanner data, 2018.

concerns regarding health and environmental sustainability. However, the capacity of different regions to respond to this demand in an equitable manner remains uncertain. This paper contributes to this debate by

providing a spatially disaggregated analysis of the Italian organic food market. Using retail scanner data, it examines product availability, packaging formats, and organic-conventional price differentials across categories and provinces. The empirical findings provide a clear basis for targeted policy interventions. In particular, the observed territorial disparities in retailer coverage, product availability, and organic-conventional price differentials point to distinct structural constraints that require differentiated policy responses. Linking these indicators to specific policy levers allows for a more precise identification of interventions aimed at improving access to organic food and reducing spatial inequalities.

Methodologically, the use of scanner data provides a detailed and representative mapping of consumer behaviour within the modern retail sector. Unlike survey-based approaches, it captures actual market transactions, thereby enhancing the robustness and credibility of the resulting indicators. This market-based evidence makes it possible to document territorial disparities in access to sustainable food with greater precision, an aspect of particular relevance in contexts characterised by unequal income levels, retail infrastructures, and food availability.

The results reveal three main findings. First, packaging sizes for organic products are systematically smaller than those of their conventional counterparts, with significant differences across all categories. While smaller packages may appeal to environmentally conscious consumers and support portion control, they can also reinforce perceptions of organic food as less economically accessible, particularly for low-income households. At the same time, they may lower the absolute price threshold, encouraging trial purchases and acting as a potential entry point into organic consumption.

Second, market coverage analysis uncovers a clear territorial divide. Provinces in central and northern Italy benefit from a broader assortment and higher retail presence of organic products, while southern provinces remain underserved, with fewer points of sale and more limited product diversity. This suggests that physical access - not only consumer preference - continues to constrain organic consumption in several areas. From a broader food-access perspective, the observed North-South divide points to the presence of food desert-like conditions in parts of the country. In these areas, limited retail coverage and reduced product variety constrain access to organic and, more generally, to healthy and sustainable food options, independently of individual preferences or awareness. While the concept of food deserts has been primarily developed in North American contexts, growing evidence highlights that similar forms of spatial food-access deprivation may emerge in European settings characterised by uneven retail development and territorial inequalities. Our findings suggest that, in Italy, such conditions are more likely to affect southern regions, where structural gaps in retail infrastructure interact with higher price premiums, reinforcing barriers to sustainable consumption. The exclusion of alternative retail channels may lead to an underestimation of organic availability, particularly in regions where short supply chains and local markets are more prevalent. Third, hedonic price modelling indicates consistent organic-conventional price differentials across all product categories. These differentials vary markedly across provinces and are particularly pronounced in some regions, pointing to persistent barriers to broader consumer adoption. The mismatch between supply-side availability and market shares further highlights demand-side constraints, which may be associated with income levels, food literacy, and perceived value. From a policy perspective, these findings underscore the need for interventions that address both consumer affordability and structural bottlenecks. Reducing certification costs—particularly in regions with fewer organic operators—through simplified procedures or collective certification schemes could lower entry barriers for producers Zezza et al., 2020. Supporting regional bio-districts and short food supply chains would enhance logistical efficiency and local coordination, helping to contain price differentials [53]. Similar vulnerabilities in supply-chain responsiveness were observed in the UK during the

COVID-19 crisis, when sudden demand shocks for staples such as eggs and flour exposed structural weaknesses in food distribution systems [2]. Strengthening these infrastructures is therefore essential for ensuring both resilience and equitable access to sustainable food. Incentives for retailers to expand assortments in underserved areas, coupled with investment in food infrastructure in the South, could help reduce disparities in access. Complementary demand-side instruments, such as targeted vouchers for low-income households, may further ensure that the transition to organic consumption is socially inclusive. Consumer awareness campaigns remain essential, but they should be tailored to different territorial contexts and engage both consumers and retailers. Retailers, in turn, could respond to regional disparities by adjusting product assortments and pricing strategies to reflect local conditions. By reducing territorial inequalities in organic food markets, these measures directly contribute to SDG 12 on Responsible Consumption and Production, ensuring that the transition to sustainable diets is not only environmentally sound but also socially inclusive. Importantly, the effectiveness of these interventions depends on territorial conditions. In regions characterised by weaker retail infrastructures and higher price premiums—such as parts of Southern Italy—policy efforts should prioritise improving physical access and reducing supply-side constraints. In contrast, in areas where availability is relatively high but market shares remain low, policies should focus more on affordability and consumer engagement.

Although focused on Italy, our findings have broader international relevance. Similar mismatches between strong organic production and limited domestic consumption are observed in countries such as Spain and Greece, while North-South divides and regional inequalities are also documented in Eastern Europe and within high-income countries such as Norway [55,56]. By integrating scanner data with hedonic modelling and territorial indicators, our framework offers a replicable tool for assessing sustainable consumption disparities in diverse international settings. This study also has limitations. First, the data are limited to modern retail channels, excluding alternative outlets such as farmers' markets or direct producer sales. Second, the indicators are supply-side in nature and do not directly capture consumer preferences or perceptions. Third, while regional patterns are highlighted, household-level socio-economic variables are not incorporated, which would allow for a more detailed understanding of purchasing behaviour. Overall, these findings highlight that promoting equitable access to organic food requires coordinated interventions addressing both structural and demand-side barriers. By explicitly linking empirical evidence to policy design, this study contributes to the development of more targeted and effective strategies to support inclusive transitions towards sustainable food systems.

Future research could explore how recent economic shocks, such as post-COVID changes in consumption patterns and the rise of inflation, have affected organic demand and affordability. Incorporating discount retailers—where organic sales have grown markedly in recent years ISMEA, 2023—would provide a more comprehensive representation of the retail landscape and help assess whether alternative pricing strategies mitigate access barriers. Further investigation into the structural drivers of organic-conventional price differentials, including supply-chain logistics, retailer strategies, and regional economic conditions, would also be valuable. In addition, future work could further deepen the analysis of territorial disparities by explicitly accounting for spatial dependence in both market indicators and price differentials. Spatial exploratory tools, such as Moran's I and Local Indicators of Spatial Association (LISA), could be used to assess the presence of spatial clustering in availability, market presence, and organic price premiums. From a methodological perspective, alternative model specifications could also be explored. Quantile regression approaches would allow the assessment of heterogeneity in organic price premiums along the price distribution, shedding light on whether affordability gaps are more pronounced for lower- or higher-priced products. Where data structure permits, double-log specifications could be compared with the semi-log

framework to test the sensitivity of results to functional form assumptions. Finally, further disaggregation of price premiums by private-label versus branded products and by package size formats would provide additional insights into retailer strategies and their implications for territorial affordability. Taken together, these extensions would further strengthen the role of scanner data as a key empirical tool for analysing spatial inequalities in sustainable food systems and for supporting the design of targeted, evidence-based policies.

Declaration of competing interest

The authors declare no competing interests.

CRediT authorship contribution statement

Iliaria Benedetti: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. **Tiziana Laureti:** Conceptualization, Funding acquisition, Project administration, Supervision, Validation. **Luigi Palumbo:** Conceptualization, Data curation, Methodology, Software, Visualization, Writing – original draft.

Acknowledgements

This research was funded by the Italian Ministry of University and Research (MUR) under the PRIN 2022 Programme (Projects of Relevant National Interest), Project Title: “Digital Innovation in Price Statistics: Open and Fast Insights from Online Scraped Data”, Prot. 2022HTZY2N, CUP J53D23004670006.

Data availability

The retail scanner data used in this study are third-party data licensed to ISTAT; due to contractual restrictions they are not publicly available. Aggregated outputs and code used to produce the tables and figures will be shared upon request.

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