Food Security
https://doi.org/10.1007/s12571-024-01456-x

ORIGINAL PAPER

Food expensiveness in remote areas of Scotland: a natural experiment measuring the out-shopping effect

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Received: 21 November 2023 / Accepted: 2 May 2024
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Abstract

This paper investigates the effect of out-shopping (i.e., buying food outside local area) on food expensiveness in remote areas in Scotland, contributing to the literature on social factors affecting food security and food affordability in remote rural areas worldwide. It identifies out-shopping as a factor explaining why existing studies observing food prices at local stores in remote areas find much higher prices than at urban stores, while studies observing actual purchases of household in remote areas find small differences in food expensiveness with urban households. To investigate this difference, a food expensiveness index was constructed using home scanner data measuring households' actual purchases. Data from the 2020 COVID-19 lockdown, when travel restriction limited out-shopping, were compared with the same period in 2019 when such restrictions were not in place. The results find that the premium paid in remote rural areas was small overall, but a statistically significant increase during lockdown was found for those households that lost access to discount stores because of movement restrictions. This result indicates that out-shopping is an important factor limiting food expensiveness in remote areas of Scotland and thus ensuring food affordability. Data suggest that approximately 42 percent of households in Scotland remote areas rely on out-shopping for obtaining affordable food.

Keywords Remote rural areas · Food affordability · Food availability · Rural development · Home-scanner data

1 Introduction

There is a consistent literature investigating whether food prices in remote areas are higher than those in cities and urban areas, with conflicting results. In this respect, several studies measuring store prices in remote areas found significant differences, depending on the study location and the goods in the food basket that was considered in the investigation. Examples of these studies in Scotland include BBC News (2016), Cummins et al. (2010), Dawson et al. (2008), Dumfries and Galloway Citizen Advice Service (2015, 2017) and Hirsch et al. (2013, 2016); studies on Australia include Beaulac et al. (2009), Ferguson et al. (2016), Palermo et al. (2008), Pollard et al. (2014), Tsang et al. (2007) and Ward et al. (2012); studies on the USA and Canada include Bardenhagen et al. (2017).

The aforementioned studies share a similar structure: a "reference basket" is chosen (usually, composed of healthy food products for a balanced diet or subsistence goods), then shelf prices of the basket are collected at representative stores in remote and urban areas and compared. Determinants of the differences are identified as well (e.g., type of store, household characteristics, level social deprivation in the area).

The majority of those studies found large "remoteness premium" (i.e., difference in prices, with food in remote areas being more expensive). In Scotland the premium ranges between 10 and 40 percent depending on the type of goods in the basket, location, and store type (e.g., Hirsch et al. 2013).

A recent study also for Scotland using a different approach did not confirm the above results. Revoredo-Giha and Russo (2023) used actual household purchases from a home-scan survey for the period 2017 to 2018 instead of collecting shelf-prices and concluded that although the

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Published online: 08 June 2024

difference in food expensiveness between rural urban areas was statistically significant, it was not economically relevant as it was less than 1 percent.

The remarkable difference between the estimates may be due to several causes. First, the reference baskets that are used in shelf-price analyses may differ from actual purchases. In theory, consumers in a remote area might purchase cheap items that are sold at prices that are similar to the ones in urban areas. This hypothesis is consistent with the conclusions by Whelan et al. (2018) suggesting that it may be difficult to buy healthy food in remote areas because it is too expensive, or it is not available. From this perspective, shelf-price analysis and actual-purchase studies may differ because households in remote areas do not buy the reference baskets.

The second reason is that consumers living in remote areas might shop elsewhere, for example in accessible areas where they work or may go for shopping trips. This "out-shopping" behavior was described by Bardenhagen et al. (2017), Marshall et al. (2018) and Whelan et al. (2018), who identified a vicious circle where out-shopping results in lower demand and competitive disadvantage for local stores and, ultimately, higher local prices providing incentives to further out-shopping. According to this hypothesis, the results of shelf-price analysis and those of actual-purchase analysis differ because consumers do not buy food at local stores.

This paper investigates the effect of out-shopping on food expensiveness in rural areas in Scotland taking advantage of a natural experiment. Food expensiveness during the 2020 COVID-19 lockdown (when travel restrictions discouraged out-shopping) is compared with data from the same time of the year in 2019. It is assumed that the difference – after controlling for the change in the purchased bundle of goods – may be attributed to the out-shopping effect. Hence, the objective of the empirical analysis is to assess if out-shopping can explain the difference in the estimates of the remoteness premium. This is an important question due to its policy implications.

If out-shopping is a major purchasing behavior in remote areas, one can assume that the remoteness premium is the result of discrimination. According to spatial arbitrage theory, the price at local stores must be equal or lower than the price in other areas plus the transport cost (i.e., the cost of fuel, the opportunity cost of time, etc.). If the transportation cost is heterogeneous, local stores can apply high prices to households with high transportation costs (for example because of lack of public or private transportation, bad road infrastructures), while other households can shop outside the local area. This can be considered a discrimination scheme based on difference in transportation costs. High food prices affect households with costly travel arrangements more than others. In this case, supporting these household and local stores (breaking Whelan et al.'s (2018) vicious circle) is a priority policy objective.

Instead, if out-shopping is not a key determinant and the observed difference in food expensiveness estimates is due to mainly to basket composition or other factors, the main policy objectives relate to make healthy and quality food baskets affordable and available, changing store assortments and relative prices of goods. From this perspective, our evaluation of the out-shopping effect supports the design of effective public policies to improve health and nutrition in remote areas and to support local economy.

The paper is organized as follows. Section 2 illustrates the measure of food expensiveness, Section 3 introduces the testing strategy for out-shopping effects, Section 4 presents results, and Section 5 concludes.

2 Approach to measure food expensiveness and remoteness premium

Following Revoredo-Giha and Russo (2023), this study uses the Aguiar and Hurst (2007) index (AHEI) to measure food expensiveness at household level. AHEI is obtained from the ratio between the actual food expenditure in the time of reference and the cost of the same bundle if prices of each good were equal to the quantity-weighted average of prices paid by all households. The index is computed as follows.

Consider household i running T^i shopping trips in the period of interest m, each time choosing a bundle of goods from the set J of available food products. Household i's food expenditure is:

$$E_m^i = \sum_{j=1}^{J} \sum_{t=1}^{T^i} p_{j,t}^i q_{j,t}^i$$

where p's are actual prices paid by the household, q's are purchased quantities (can be zero), and subscripts j and t refer to products and shopping trips, respectively. The quantity-weighted price average of product j in period m is defined as

$$\bar{p}_{j,m} = \sum_{i=1}^{N} \sum_{t=1}^{T^i} p_{j,t}^i \left(\frac{q_{j,t}^i}{\sum_{i=1}^{N} \sum_{t=1}^{T^i} q_{j,t}^i} \right)$$

where is the total number of consumers.

If the household paid the quantity-weighted prices for the same basket of goods, the cost is:

$$\tilde{E}_m^i = \sum_{j=1}^{J} \sum_{t=1}^{T^i} \bar{p}_{j,m} q_{j,t}^i$$

Given the ratio:

$$R_m^i = \frac{E_m^i}{\tilde{E}_m^i}$$

The AHEI is a normalized R_m^i so that in each month the index is centered on 1000:

$$AHEI_m^i = \frac{R_m^i}{N^{-1}\sum_h^N R_m^h} \times 1000$$

The $AHEI_m^i$ is defined at household level over the period of interest (i.e., it can include multiple shopping trips). For the sake of simple notation, we drop the subscript m and superscript i in the remainder of the paper. A value of AHEI that is greater (lower) than 1000 indicates that on average household i paid more (less) for their food basket than they would have if they bought it at average prices.

AHEI is an average measure; for example, values close to 1000 can be achieved either if all prices are close to the quantity-weighted average or if prices of a subset of goods are remarkably higher than the average and prices another subset of goods are remarkably lower, so that the two effects offset each other. This feature provides a possible explanation why shelf-price analysis studies provides different estimates of the remoteness premium. If the reference basket (for example, heathy food) is expensive but other products (e.g., junk food) are cheap, the shelf-price analysis estimates high remoteness premium, while actual-purchases studies obtain lower estimates.

AHEI has several interesting features that make it an appropriate measure of food expensiveness. A key problem in comparing food expenditure is that consumers buy heterogeneous bundles of goods. Therefore, simply comparing total expenditure does not provide meaningful information. If households in urban areas buy different bundles of goods than those in remote areas, different values of total food expenditure are not proof of a remoteness premium. Shelf-prices analysis studies control for this problem because they use an exogenously determined reference basket that is the same for all households (e.g., a healthy basket or a subsistence bundle). The downside of this approach is that the reference basket may not reflect the actual purchases. If the reference bundle is not representative of actual purchases, the result of the analysis might be irrelevant, and inference of the remoteness premium might be biased.

Actual-purchase studies control for heterogeneous bundles in a different way. The AHEI addresses the issue comparing the expenditure of each household with the expenditure for an identical bundle at quantity-weighted average prices. Hence, the AHEI compares actual purchases and prices with a sort of reference prices (i.e., the quantity-weighted average prices) for the same bundle. In this way, differences in the quality of composition of households' baskets do not affect the results, because each observation is compared to an identical bundle.

The advantage of the AHEI approach is that the analysis is based on actual purchases and there is no need to impose a a-priori reference basket, which the household may or may not be purchasing. The index measures how much – on average – actual prices are higher than the quantity-weighted average prices for the period observed bundle. This measure is consistent with the study question and the AHEI can be used to provide a measure of the remoteness premium.

The premium can be measured in two ways. The *absolute* premium is the difference between the average AHEI of the group and the baseline value (1000), the *relative* premium is the difference between the average AHEI of two groups. For example, consider a group R of household living in remote areas and a group composed of all other households (NR). The absolute remoteness premium (AP_m^R) and the relative remoteness premium ($RP_m^{R,NR}$) in period m are $AP_m^R = E^R\left(AHEI_m\right) - 1000$ and $RP_m^{R,NR} = E^R\left(AHEI_m\right) - E^{NR}\left(AHEI_m\right)$, were $E^R(.)$ and $E^{NR}(.)$ are simple average operators taking expectations of AHEI for all households in R or NR, respectively.

Intertemporal comparison of remoteness premia is possible, but it must be interpreted carefully. For example, if an increase in the absolute premium is observed (i.e., $AP_{m+1}^R > AP_m^R$) it is not possible to conclude that food expenditure increased. The inequality simply states that on average the percent difference between actual prices and average prices increased, but because both the food basket and the average prices in the two periods may be different, no inference on food expenditure can be made. Similarly, it is not possible to conclude that prices of a given bundle increased, because the bundles in the two period are likely to differ.[1] The inequality simply means that the relative magnitude of the difference between actual prices and quantity-weighted average prices increased, without considering the composition of the two baskets. A key advantage of AHEI in intertemporal comparison is that it controls for changes of the food bundle over time. Because in each period the actual expenditure is compared with the cost at average prices of the same bundle, variation in consumption does not affect the estimates. This point is of particular importance in the natural experiment that is described in the next section.

[1] To clarify this point, assume a AHEI equal to 1500 at a given time t. The index means that the household is spending 1.5 times more than they would have if they had faced average prices at the same period. The value cannot be compared with the index value at time $t+1$ simply because the average price vector can change. For example, if AHEI index is equal to 1400 at time $t+1$, it is not possible to conclude that prices at time $t+1$ are lower than prices at time t. The appropriate conclusion is that at time $t+1$ the percent difference between actual expenditure and the expenditure computed at average price is smaller at time $t+1$ than at time t.

3 The effect of out-shopping on food expensiveness in remote areas

In order to assess the impact of out-shopping on food expensiveness this study took advantage of a natural experiment, namely, that during the COVID-19 lockdown out-shopping was strongly discouraged. The AHEI was measured from a sample of households in remote and urban areas of Scotland during the COVID-19 lockdown in the UK (from March 26th to June 23rd 2020) and the same period in 2019.

The empirical analysis is based on two assumptions: (a) COVID-19 Lockdown resulted in more difficult out-shopping, limiting access to discount stores among other things; and (b) lockdown limited outshopping in remote areas more than in non-remote areas, because of the more limited availability of nearby food sources in remote areas than elsewhere. Therefore, we can consider lockdown as a natural experiment imposing limitations to out-shopping. Non-remote (and urban in particular) households are used a control group to assess the effects of such out-shopping limitations in remote areas using a difference in difference approach.

The natural experiment is based on the assumption that movement restrictions that were imposed during the lockdown limited out-shopping opportunities. People was required to stay at home, permitted to leave for essential purposes only, such as buying food or for medical reasons and non-essential business were closed. Movement between municipalities was restricted as well. Shopping outside local areas was more difficult and therefore it is expected that most shopping happened at local stores during the lockdown. It must be noted that out-shopping may refer to a wide range of different situations. For example, in mainland Scotland, out-shopping may result in driving to the nearest town, while in the islands it might involve longer and multi-modal trips. Thus, for the purpose of this investigation, we define out-shopping as shopping for food from sources that are inhibited or restricted by COVID-19 lockdown restrictions.

If prices at local stores in remote areas are high and households were out-shopping to contain expenditure, movement restrictions result in an increase in *relative* food expensiveness and AHEI in remote areas compared to urban areas. If the out-shopping hypothesis is true, the effect of lockdown on food expensiveness in urban areas is expected to be lower, because shoppers do not have to travel far to find low-price stores. Consequently, it is possible to test the effect of out-shopping comparing the relative remoteness premium between remote and urban areas before and during lockdown. If lockdown constrained out-shopping effectively and if out-shopping was effective in reducing food expensiveness in rural areas, the relative remoteness premium is expected to increase.

AHEI can be applied even if consumption patterns changed during the lockdown. In fact, because of the stay-at-home regulation, the number of at-home meals increased during lockdown, leading to an increase in the per-capita expenditure for grocery. Also, the psychological impact of the pandemics was expected to affect food choices either to a healthier diet or to an increase in the consumption of comfort food (e.g., Revoredo-Giha & Russo, 2021, 2023; Russo et al., 2021). AHEI can control for these changes, because in each period the actual expenditure is compare with the cost at quantity-weighted average prices of the current basket, and not with the expenditure of a fixed basket in a reference period. Following the discussion of the index properties in Section 2, an increase (decrease) of average AHEI in remote areas during lockdown compared to 2019 indicates that – on average – the difference between food prices in remote areas and food prices in other areas of Scotland increased (decreased), but it does not provide any information about the absolute value of prices (i.e., if prices increased or decreased with respect to previous year). Because the goal of this paper is to assess the remoteness premium (difference in averages), AHEI is an appropriate measure.

4 Hypothesis testing and data

The following two hypotheses were tested. Firstly, we tested if the lockdown affected the way Scottish households in remote areas buy food and if the effect in remote areas differed from other areas. This test validates the natural experiment. If no differences were found, no inference on out-shopping could be made. Secondly, we test for statistically significant differences in the absolute and relative remoteness premia before and during the lockdown. If households who changed their shopping behavior during lockdown exhibit higher remoteness premia, we conclude that a out-shopping effect is possible. If the null hypothesis of no change in the premia cannot be rejected, the data does not support a out-shopping effect.

In this experiment the total out-shopping effect is the result of two components: the share of households that changed the way they shop because of movement constraints and the increase in *relative* food expensiveness that those households experienced during lockdown. If data do not support the hypothesis on either change in shopping or increase in expensiveness, it is concluded that there is no evidence of out-shopping effect.

The magnitude of the change in AHEI for households that experienced movement restrictions was used to investigate the large differences in results between shelf-price and actual purchases studies. If the increase in AHEI is small, it is possible to conclude that out-shopping does not

explain the entire difference in the estimates between the two approaches and other causes concur (such as difference in baskets).

Food expensiveness in remote and urban areas was measured computing the average AHEI in a sample of 1441 Scottish households from the Kantar HomeScan dataset.[2] The sample was obtained selecting the households in the dataset that were observed in both periods, in order to assess the lockdown effect at household level. The high number of observations can be considered sufficient to provide meaningful insights.

The Scottish Neighborhood Statistics (SNS) classification was used to divide the households into three groups depending on their location in Remote Areas, Accessible Areas, and Urban Areas according to 2016 SNS classification.[3] Figure 1 provides a map of Remote Areas in Scotland. The case study is important because approximately 9 percent of Scotland population lives in Remote areas according to the 2019 UK Census (6 percent in remote rural areas and 3 percent in remote small towns).

The specific location of the store where grocery was purchased from was not reported in the Kantar HomeScan dataset. Consequently, out-shopping was not observable because it is not possible to determine whether the household shopped locally or if they travelled to a distant store. In order to describe the effect of movement restrictions on the way Scottish household shopped during the lockdown, the following set of variables was used instead:

- Average number of shopping trips per week.
- Average number of stores that the household visited per week, measuring the variety of outlets the household shopped at.
- Herfindahl-Hirschman concentration index of food expenditure by store. The index is defined as $HHI = \sum_{j=1}^{NS} s_j^2$, where HHI is the concentration index, NS is the total number of stores and s_j is store j's share of household food expenditure. The index ranges from zero (expenditure equally distributed in an infinite number of stores) to one (expenditure concentrated in a single store).
- Share of household food expenditure in supermarkets.
- Share of household food expenditure in discounters.

It is assumed that a change in the set of variables during lockdown implies that movement restrictions affected the way household shopped. Reduction in the variety of shopping outlets, increase in expenditure concentration and reduction of expenditure shares at low-prices stores (discounters) are considered as proxy indicators of limitations to out-shopping practices.

5 Results

5.1 Descriptive statistics

Table 1 presents descriptive statistics of the sample, reporting basic demographic information by area. The data refer to the primary shopper, that is the person who is more often in charge of grocery shopping. As expected, primary shoppers in urban areas are younger than those in other areas, and the average number of persons in the household is smaller.

In order to describe the price differences between Remote and Non-Remote areas, the quantity-weighted average price of each good was computed in each area and in each time interval. Then the difference between quantity-weighted average price in Remote and Non-Remote areas before and during lockdown was calculated for each good. Figure 2 reports the distribution of products by class of difference in average price. A negative difference means that the product is cheaper in Remote areas than in Non-Remote areas (3.1 percent of products in 2019 and 3.4 percent in 2020). It must be noted that the relative frequencies refer to the total number of products traded in both areas of Scotland in the considered period, and they do not report frequency of households, unlike the other tables in this paper.

Figure 2 reports a bimodal distribution of price differences, with a global mode at zero (29.0 percent of products in 2019 and 32.7 percent in 2020) and a local mode in the class between 0.25 and 0.5 relative difference. One may think this distribution as compatible with a two-step process. In the first step, it is decided whether there is a national price (i.e., the goods are sold at the same price in all Scotland) or not. If there is no national price and goods are priced locally, then the relative price difference exhibits a distribution that is compatible with the results of store price analyses (i.e., an average difference between 10 percent and 40 percent). The distribution illustrates the issues of measuring prices at local stores: if a survey

[2] Kantar HomeScan dataset is a scanner panel dataset that includes information about food and drink purchases (at the level of the actual product, including bulk products) of a sample of households.

[3] According to the 2016 Scottish Government Urban Rural Classification, 6-fold, remote areas are municipalities with population less than 10,000 and more than a 30-minute drive apart from a settlement of 10,000 population. They include remote rural areas (with a population of less than 3,000) and remote small towns (with a population between 3,000 and 9,999). Accessible areas are municipalities with population less than 10,000 and less than a 30-minute drive apart from a settlement of 10,000 population or more. They include accessible rural areas (with a population of less than 3,000), accessible small towns (with a population between 3,000 and 9,999). Urban areas include other urban areas (settlements of a population between 10,000 and 124,999) and large urban areas (settlements of a population of 125,000 and more).

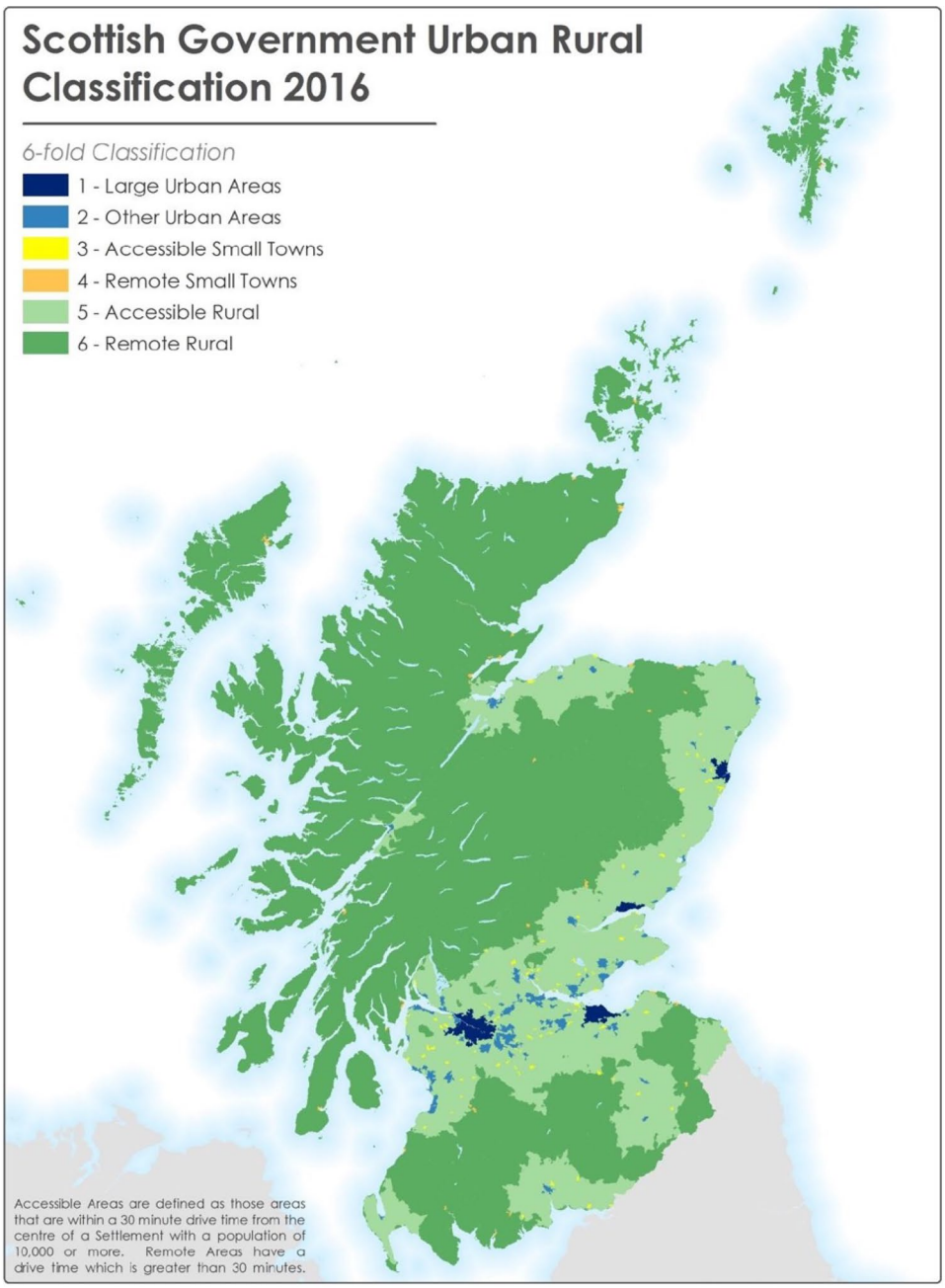

Fig. 1 Scotland - Map with area classification. Source: Scottish Government (www.gov.scot)

design somehow selects the products with no national prices, it is possible that the remoteness premium is overestimated. It must be noted that computing average price differences (or average food expensiveness indicators) items with national price compensate the large difference in locally priced items.

Access to products with national prices is a key factor reducing actual remoteness premia for households located

Table 1 Descriptive statistics of the sample

	Urban Areas	Accessible Areas	Remote Areas	Total
N. Of households	1020	271	150	1441
Average age of primary shopper[b]	48.44	50.13	51.40	49.07
Share of female primary shopper	0.71	0.76	0.71	0.72
Average n. of adults in the household[a]	1.99	2.11	2.08	2.02
Average n. of children in the household[a]	0.47	0.59	0.59	0.50

Anova rejected the null hypothesis of equality of means at 99[b] or 95[a] percent confidence level

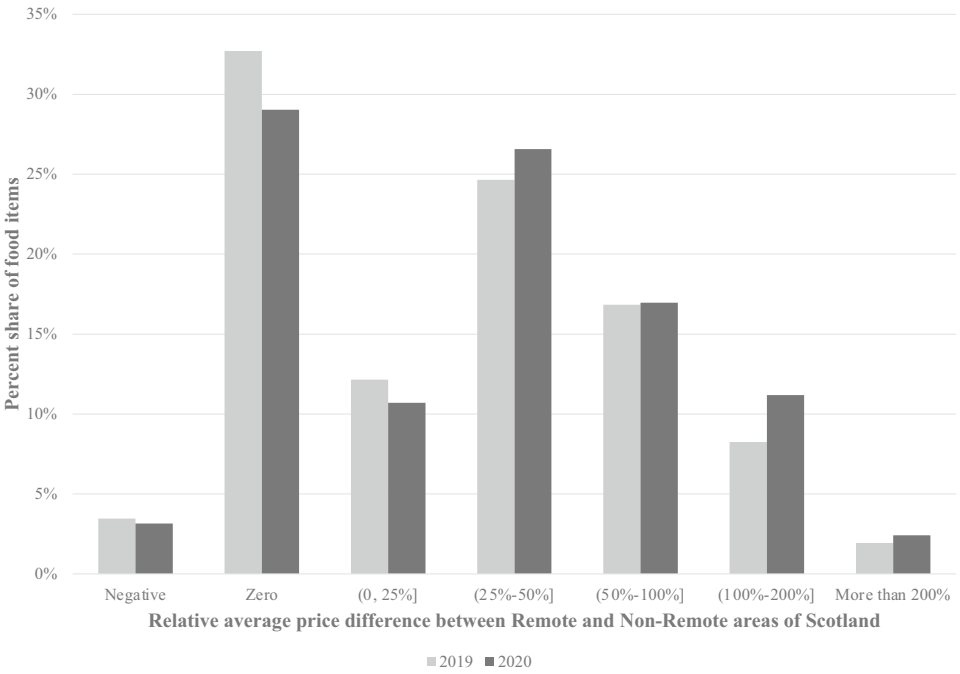

Fig. 2 Relative average price difference of food products between Remote and Non-Remote areas of Scotland (percent frequencies of food products)

in Remote areas. The purpose of the empirical analysis is to determine if out-shopping is critical for this access, using the lockdown as a natural experiment.

Figure 2 reports distributions in 2020 and 2019 that are similar but statistically different. A Kolmogorov-Smirnoff test rejected the null hypothesis of equal distribution at 95 percent confidence level. The share of products with no price difference between Remote and Non-Remote areas slightly decreased during lockdown, suggesting a small but statistically significant divergence in prices. In the next section, statistical inference is used to test if these trends are associated to changes in consumer behavior and out-shopping.

5.2 Hypothesis testing

The first hypothesis to be tested is whether the COVID-19 lockdown effectively changed the shopping behavior of Scottish households and constrained out-shopping.

Data in Table 2 show that households in remote areas in 2019, on average, visited less stores in a week, made a lower number of shopping trips, concentrated their expenditure in a more limited number of stores and bought a lower share of their food expenditure at discounters than urban households. The ANOVA found that these differences are statistically significant. The results are consistent similar studies finding that shopping

Table 2 Change in variables describing shopping behavior before and during COVID-19 lockdown (95 percent confidence intervals)

		Urban Areas	Accessible Areas	Remote Areas	ANOVA *p*-value
Average n. of stores visited/week	2019 value	4.433	4.402	3.713	0.001
	Variat. 2020-19	-0.218 ± 0.078	-0.243 ± 0.156	-0.518 ± 0.186	0.025
Average n. of shopping trips/week	2019 value	2.522	2.412	2.105	0.001
	Variat. 2020-19	-0.131 ± 0.045	-0.154 ± 0.079	-0.168 ± 0.090	0.782
Avg. expenditure HH concentration index	2019 value	0.519	0.521	0.581	0.006
	Variat.2020-19	0.012 ± 0.009	0.011 ± 0.018	0.048 ± 0.025	0.016
Average expenditure share in supermarkets	2019 value	70.548	68.728	80.327	0.001
	Variat.2020-19	0.025 ± 1.016	2.860 ± 2.256	1.045 ± 2.428	0.047
Average expenditure share in discounters	2019 value	20.935	22.228	13.347	0.001
	Variat.2020-19	-0.075 ± 0.923	-2.222 ± 2.050	-1.155 ± 2.117	0.108

The ANOVA *p*-value refers to the test of equality of the means of the three groups

Table 3 Distribution of households by area and class of change in the expenditure share for food bought at discounters

Change in expenditure share at discounters	Urban areas		Accessible areas		Remote areas		Total	
	n. of hh.	%	*n*. of hh.	%	*n*. of hh.	%	*n*. of hh.	%
Gained access	71	6.96	22	8.12	9	6.00	102	7.08
Increase/stable	354	34.71	84	31.00	28	18.67	466	32.34
Decrease	360	35.29	107	39.48	45	30.00	512	35.53
Lost access	77	7.55	18	6.64	19	12.67	114	7.91
No access	158	15.49	40	14.76	49	32.67	247	17.14
Total	1020	100.00	271	100.00	150	100.00	1441	100.00

χ^2 test on the association between the two variables rejected the null hypothesis of independence at 95 percent confidence

level (*p*-value: < 0.001, $\chi^2(8) = 42{,}389$)

behavior in remote areas has unique characteristics, with remote households having limited shopping opportunities compared to others (e.g., Marshall et al., 2018; Revoredo-Giha & Russo, 2023).

The effect of COVID-19 lockdown was measured computing the difference in the average values of shopping variables between 2019 and 2020 in each area. On average, the lockdown was associated with a decrease in the number of stores visited and in the number of trips per week. The concentration index of expenditure increased. The signs of the variations are consistent with the expected effect of a reduction in public mobility, with concentration in space and time of purchases.

During lockdown, limited evidence of variations in the expenditure shares in supermarkets and discounters, despite of the financial struggles of several households during the pandemic emergency with the Scottish economy contracting by 19.4 percent between April to June 2020 – its biggest fall in quarterly GDP on record (Scottish government, 2020). Statistically significant variations were found only in accessible areas. The large standards errors suggest heterogeneity in the lockdown effect within urban and remote areas.

The signs of the change in average values are consistent in the three areas for all variables, suggesting that the lockdown affected them in the same way. The point estimates of average variations are larger in remote areas than in urban ones. Nevertheless, standard errors are large and ANOVA tests failed to reject the null hypotheses of equal average variations at 95 percent confidence level in the case of average number of shopping trips per week and average expenditure share in discounters.

In order to account for heterogeneity within areas, we classified households based on the change in the share of expenditure for food bought at discounters. Discount chains such as Lidl or Aldi are committed to low food prices and use price leadership as main competitive strategy. If lockdown restrictions resulted in a loss of access to these stores, food expensiveness is expected to increase.[4]

An χ^2 test of association concluded that the change in expenditure share at discounters and the household location are not independent variables. Table 3 shows that the share of households in the classes "Lost access" and "No access" is higher in remote areas, while the share of households increasing or keeping constant their share of expenditure at discounters is lower. These results support the hypothesis that lockdown restriction affected food sourcing in remote area. The overall effect on food expensiveness has two components: the changes for the households who were able to keep their access to low-price food sources, such as discounters, and those who were not.

Table 4 reports the average AHEI by area and class of change in expenditure share for food bought ad discounters. Consistently with previous studies (Revoredo-Giha & Russo, 2023), a remoteness premium is paid by households living in remote areas in the measure of 3.4 AHEI points in 2019 and 5.2 points in 2020. However, the average increase by 1.8 points is not statistically different from zero (the standard error being 1.2).

Only households in remote areas who experienced a decrease in the share of food expenditure at discounters or stopped purchasing there altogether exhibit an increase in the absolute remoteness premium. The size of the increase was larger for households who lost access (6.6 AHEI points) than for those who experienced a decrease in discounter

[4] The groups are defined based on the comparison between the share of food expenditure at discounters in 2019 (DISC19) and 2020 (DISC2020). "Gained access" includes households with DISC19 = 0 and DISC20 > 0, "Increase/stable" households with DISC20 ≥ DISC19 > 0, "Decrease" households with 0 < DISC20 < DISC19, "Lost Access" households with DISC19 > 0 and DISC20 = 0, "No access" households with DISC19 = DISC20 = 0.

Table 4 Distribution of average AHEI by area and class of change in the expenditure share for food bought at discounters

Change in expenditure share at discounters	Urban Areas			Accessible Areas			Remote Areas			Total		
	2019	2020	Variat.	2019	2020	Variat.	2019	2020	Variat.	2019	2020	Variat.
Gained Acc.	1002.6	1001.1	-1.5	1002.0	1002.6	0.6	1002.1	998.3	-3.8	1002.5	1001.2	-1.3
	(2.0)	(2.1)	(1.8)	(3.6)	(3.1)	(2.0)	(8.6)	(4.3)	(8.4)	(1.7)	(1.7)	(1.5)
Increase	996.1	994.9	-1.2	997.3	997.9	0.6	999.3	997.2	-2.0	996.5	995.6	-0.9
	(0.8)	(0.7)	(0.7)	(1.4)	(1.4)	(1.4)	(2.8)	(2.2)	(2.5)	(0.7)	(0.6)	(0.6)
Decrease	998.2	998.0	-0.2	997.3	998.9	1.7	998.0	1001.6	**3.6**	998.0	998.5	0.5
	(0.7)	(0.7)	(0.7)	(1.0)	(1.1)	(1.1)	(2.0)	(1.8)	**(1.3)**	(0.6)	(0.6)	(0.6)
Lost Access	1005.3	1005.9	0.6	1002.2	1007.9	5.8	998.7	1005.2	**6.6**	1003.7	1006.1	2.4
	(1.8)	(1.9)	(1.5)	(4.6)	(5.1)	(3.8)	(4.3)	(4.6)	**(3.1)**	(1.6)	(1.7)	(1.3)
No Access	1006.9	1006.5	-0.3	1007.5	1007.4	-0.1	1012.6	1014.3	1.7	1008.1	1008.2	0.1
	(2.0)	(1.4)	(1.9)	(2.3)	(2.9)	(2.2)	(3.3)	(2.7)	(2.7)	(1.5)	(1.1)	(1.3)
Total	999.6	999.0	-0.6	999.5	1000.7	1.3	1003.4	1005.2	1.8	1000.0	1000.0	0.0
	(0.5)	(0.5)	(0.5)	(0.8)	(0.9)	(0.8)	(1.6)	(1.4)	(1.2)			

Numbers in parenthesis are standard errors of the mean, bold fonts indicate variations that are statistically different from zero at 95 percent confidence level

expenditure share (3.6 points). This result is consistent with an out-shopping effect. Only in the case that lockdown restrictions resulted in a limitation in the use of low-price food sources, food expensiveness increases. Noticeably, there was no statistical evidence of a similar effect for a reduction in supermarket expenditure shares.

The comparison of urban and remote households who lost access to discounters, shows that during lockdown they exhibited similar values of average AHEI (1005.9 versus 1005.2, respectively). Yet, the values before lockdown in 2019 were different (1005.3 for urban households versus 998.7 for remote ones). This finding suggests that loosing access to discounters may have a different effect in urban and remote areas, with a much larger impact in the latter case. Although more evidence is needed for a conclusion, a possible explanation is that discounters in urban areas were substituted with similar sources (e.g., supermarkets), while in remote areas they were substituted with more expensive alternatives (e.g., local stores). This result is consistent with the existence of an out-shopping effect.

6 Conclusions

This paper investigated the effects of out-shopping on food expensiveness in remote areas of Scotland using COVID-19 lockdown as a natural experiment. The study confirms previous results obtained with a similar approach (Revoredo-Giha & Russo, 2023) finding that a remoteness premium exists, but its magnitude is limited (in 2019 it was 3.4 points on a 1000 scale).

The estimate of the out-shopping effect accounts for a fraction of the difference between the findings of shelf-price studies (a price difference between 10 and 40 percent) and actual-purchase investigations (a difference in food expensiveness of 1 percent or less). This implies that other factors should explain the gap, including the difference between the reference basket that is used in the study and the actual baskets that are purchased by households in remote areas.

The empirical analysis found that lack of access to low-price food sources like discounter is a key driver of food expensiveness. This result is consistent with previous literature pointing out that accessibility and affordability of healthy food is affected by the presence of medium and large stores in the area (Dawson et al., 2008). When the movement restrictions that were imposed during the lockdown resulted in a loss of access to discounters, the food-expensiveness measure AHEI in rural areas increased on average by 6.6 points, a value that is almost double of the average remoteness premium. If lockdowns resulted in reduction in the use of discounters, an increase of average food expensiveness in remote areas was observed. Similar trends were not detected in urban areas.

The study supports the hypothesis that out-shopping is an important factor limiting food expensiveness in remote areas of Scotland. The conclusion has several policy implications. The issue of high food prices at local stores in remote areas may be less severe than predicted by shelf-price analysis, because of most households are able to travel to nearby sources of low-price food. We found that, when movement restriction applied, 12.7% of households in remote area stopped purchasing from discounters altogether and 30% reduced their expenditure share at discounters. In total, lockdown restrictions limited access to discounters in 42.7% of households. These data support the conclusion that out-shopping may help a sizable share

of population in rural areas reaching low-price stores. The finding rises concerns about the effects of recent fuel-price spike on food security in Scotland. By increasing transportation costs and making out-shopping more expensive, high fuel price may affect the remoteness premium. This relates to the current public debate about fuel poverty in Scotland, that is household inability to achieve sufficient living standards after paying for fuel costs necessary for the home (e.g., Davis et al., 2021). It points out to the need to maintain and/or improve the public transport options because they allow consumer from remote areas (e.g., islands) to have the possibility to access shops different than those locally available and which may offer lower prices. This can be clearly seen in several pieces by the BBC News (2016, 2022, 2023) where islanders complain about both the availability of shops and the effects that ferry cancelations have impacted on every aspect of their life.

There were 32 percent of remote households in the study sample that did not shop at discounters and paid a premium of 12.6 AHEI points in 2019 and 14.3 points in 2020. These values are between three and four times higher than the average remoteness premium. Although the values are still relatively small (approximately 1 percent of the cost of the basket at average prices), there is a possible distribution effect of high local food prices that may harm household who are unable to travel for food shopping. Also, it must be noted that this study does not consider the dietary implications that may arise from higher prices for healthy food baskets. In fact, the estimate is based on actual purchases and households may substitute healthy product with cheaper alternatives to reduce food expensiveness (Dawson et al., 2008).

A clear implication of the study is the need for the Scottish Government to ensure the normal functioning of public transport as it reduces the isolation of remote areas and allow their population not only to improve their living standards but also make those areas more resilient to cost of living crisis as well as sustainable.

There are several issues that can be addressed in future research for further understanding of the implications of out-shopping. Our dataset does not include the shop addresses, which prevents to compute transportation costs and, consequently, the full cost of out-shopping cannot be computed. The evaluation of the remoteness premium might increase once the difference in shopping-travel cost between remote and non-remote areas is considered.

In addition, our analysis did not address the implications of out-shopping and remoteness premia on dietary choices. The discussion focused on average food expensiveness only, without investigating the composition of food baskets or healthy eating choices. Future research might investigate whether out-shopping makes healthy food more available and affordable to households in Remote areas, contributing to the extensive literature on the topic. Finally, the empirical analysis concluded that discounters play an important role in lowering food expensiveness in Remote areas. New openings of discount stores in Remote areas may benefit consumers but may affect local businesses as well. The net social effect is a topic for future research.

Funding The work received funding support as part of The Scottish Government's Strategic Research Programme 2022-27, Topic B-4: Food Supply and Food Security.

Declarations

Conflict of interest The authors declared that they have no conflict of interest.

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Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

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