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Food Expensiveness in Scotland's Remote Areas: An Analysis of Household Food Purchases[☆]

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ABSTRACT The purpose of this paper is to investigate whether consumers in Scotland's remote areas suffer from food prices that are higher than the average national prices (i.e., whether a “remoteness premium” exists). The question has been raised by several organizations in those communities looking at the high prices in local stores. This paper provides a new perspective using actual purchasing prices of a sample of 5,252 households in Scotland for 2017 and 2018. In this way, households' ability to shop for lower prices is considered, unlike in previous studies. An expensiveness index was computed to measure the expensiveness of food at household level and control for differences in quality. It showed that consumers in remote areas pay a small premium (0.3 to 0.4 percent) with respect to average prices, which is statistically significant but economically not relevant. To understand the effect of several factors, AHEI was regressed on a number of explanatory variables including local area characteristics and household demographics and consumers' shopping strategy. The results were used to simulate three hypothetical scenarios related to impact of changes in the population's age, access to discount stores, and social deprivation on food expensiveness.

Introduction

Traditionally, there have been concerns that remote communities are particularly affected by higher grocery prices in comparison with average prices or prices in urban areas. This may be because of higher transportation costs or even the possibility that retailers may have spatial market power (e.g., Clarke 2000; McEachern and Warnaby 2006; Paddison and Calderwood 2007; Smith et al. 2010). Higher prices affect not only the well being of remote communities but also their future.

Investigating the remoteness premium and food affordability is motivated by existing research showing that households in remote areas of

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Scotland have higher expenditure for food than others. Advice work has expressed concerns that residents of small settlements in Dumfries and Galloway (Scotland), which have a local economy primarily based on agriculture and forestry with a range of light industries and tourism, where public transport is limited throughout the region, often have to pay high prices for food (Dumfries and Galloway Citizen Advice Service 2015; 2017). Other similar evidence comes from studies carried out by Highlands and Islands Enterprise for remote rural areas in Scotland (e.g., BBC 2016; Hirsch et al. 2013; 2016). In addition, Scotland is an interesting case to study remote rural areas prices and compare them with urban part of the country given the substantive proportion of small rural communities (Melo 2015).

A common characteristic of the above studies is that either they use a basket of goods that are not necessarily related to actual basket of goods used by consumers, or they use aggregated categories, where the presence of different qualities distorts price comparisons (Beatty 2010).

This study contributes to the discussion of whether rural areas pay higher prices by considering an index based on consumers' actual purchases, using household data disaggregated at the level of products, which avoids quality issues. Hence, the objective of this paper is to assess whether households living in remote areas of Scotland pay more for their food basket than consumers living elsewhere. An econometric analysis is used to assess the existence of a "remoteness premium" (i.e., higher-than-average food expensiveness in remote areas), identify the main driving factors and discuss possible implications of major demographic trends.

Remoteness in this paper is defined based on The Scottish Government Urban/Rural Classification (Scottish Government 2018), which provides a consistent way of defining urban and rural areas across Scotland. The classification is based upon two main criteria: (1) population, as defined by the National Records of Scotland (NRS), and (2) accessibility, based on drive time analysis to differentiate between accessible and remote areas in Scotland. The definition of the different areas is presented later in the paper.

The results of the empirical investigation support the conclusion that difference in average food expenditure between remote and non-remote areas is not driven by prices. Using the Kantar Worldpanel database for Scotland an 8 percent difference in per-household food expenditure between remote and non-remote areas was found, while the estimate of the remoteness premium was less than 1 percent, therefore, the magnitude of the price difference is small compared to differences in expenditure. The econometric analysis suggested that existing trends such as

aging population or rural development are not expected to affect the low difference in prices.

The structure of the paper is as follows: it starts with a literature review focused on the discussion of high prices in rural areas in Scotland (Section 2). Next, the empirical strategy is presented (Section 3) and the remoteness premium is computed (Section 3.1). A set of variables that are expected to affect food expensiveness is identified (Section 3.2) and a regression model is used to compute the contribution of each factor (Section 3.3). In Section 4, the model is used to discuss the possible effects of demographic trends and public policy on food expensiveness. Section 5 concludes.

Literature Review

The purpose of this section is to provide an overview of studies that focus on food prices in remote areas and whether these are different from a major population center. The section starts reviewing international studies and is followed by those on Scotland, which are the motivation of the current paper.

There is a long tradition of price analysis in economics, which has mostly focused on identifying the characteristics of markets and in particular presence of market power. In the latter studies, paramount for that purpose have been the studies on price transmission, which have concentrated on price adjustments -in contrast to absolute value of prices- to shocks due to the presence of changes in such factors as policy measures, transaction costs, adjustment costs, market power, or risk on food markets (e.g., Vavra and Goodwin 2005).

The other branch of price studies, which is much closer to the topic of this paper, did not start with but was intensified by the increase in prices around the world during the financial year 2007–2008. The focus of this branch is associated with the analysis of affordability, where prices are important factors. Many of these studies have focused to verify whether a basket of healthy food products was similarly priced in remote areas as in a major population center. The methodology used consisted of carrying out a shelf analysis (i.e., checking prices for the selected basket in stores). Here, we compare international studies analyzing differences in prices with those focused on Scotland considering the following categories: households characteristics (e.g., which include the role of socioeconomic disadvantages, poverty, and deprivation); local area characteristics (e.g., degree of rurality); presence of policy (e.g., subsidies passed to consumers) and type of retail outlet. Table 1 summarizes several studies dealing with price comparisons.

Table 1. Characteristics of Studies Analyzing Prices

Study	Place	Motivation	Method
Tsang et al. (2007)	Australia. 5 local government areas (LGAs) in metropolitan Adelaide. Selected based on ranges of socioeconomic status (SES)	Some people do not have access to affordable, healthy foods	It studied the cost, availability and affordability of a standardised healthy food basket (HFB). A reference family was used as the basis for the costing a HFB. Prices of food items were collected in selected suburbs in May, August and September in 2005. Cost of the Adelaide HFB was compared with welfare payment and average weekly earnings
Palermo et al. (2008)	Australia. 5 local government areas (LGAs) in metropolitan Adelaide. Selected based on ranges of socioeconomic status (SES)	Some people do not have access to affordable, healthy foods	They use a cross-sectional survey of the cost of food undertaken in 2007 in a convenience sample of 34 supermarkets in rural areas across Victoria using the Victorian Healthy Food Basket (VHFB)
Beaulac et al. (2009)	Considered several high-income countries	To study the so called "Food deserts" (i.e., areas characterized by poor access to healthy and affordable food which may contribute to social and spatial disparities in diet and diet-related health outcomes)	Systematic review of the presence of food deserts in socioeconomically disadvantaged areas in several income countries
Ward et al. (2012)	Australia	Australian consumers situation due to increases in costs of basic food, and during the financial year 2007–2008	Their study used the Healthy Food Basket (HFB) methodology which were costed at supermarkets and stores in different locations with different degrees of rurality

Table 1. Continued

Study	Place	Motivation	Method
Pollard et al. (2014)	Western Australia (WA)	The impact of geographic factors on food pricing and quality in WA	A Healthy Food Access Basket was costed and a visual and descriptive quality assessment of 13 commonly consumed fresh produce items was conducted in-store on a representative sample of 144 food grocery stores
Ferguson et al. (2016)	Remote Indigenous community stores and capital city supermarkets in Northern Territory, Australia	Study the average price difference between foods and beverages in remote Indigenous community stores and capital city supermarkets and explore differences across products	They used a cross-sectional survey that compared prices derived from point-of-sale data in 20 remote Northern Territory stores with supermarkets in capital cities of the Northern Territory and South Australia for groceries commonly purchased in remote stores. Average price differences for products, supply categories and food groups were examined
Bardenhagen et al. (2017)	Northeast Lower Michigan	To inform healthy food financing projects such as the Michigan Good Food Fund. This was because residents of rural areas may have limited access to healthy foods, leading to higher incidence of diet related health issues	The area's retail food businesses were categorized using secondary licensing, business, and nutrition program databases. Twenty of these stores were visited in person to verify the validity of the categories created, and to assess the availability of healthy foods in their aisles. In-depth interviews with key informants were carried out with store owners, economic development personnel, and other food system stakeholders having knowledge about food access, in order to learn more about the specific challenges that the area faces

Table 1. Continued

Study	Place	Motivation	Method
Naylor et al. (2020)	25 remote communities in Nunavut (Canada)	To study the pass-through rate of a consumer subsidy carried out by the Canadian government to food retailers	They estimated an econometric model in which the variation in the level of the subsidy (or tax in his case) explains variation in final price. This data contains prices for 232 food items, on average, for each community in Nunavut in 2017. Not all communities have the same selection of food items, as some items may have been unavailable in a community when food prices were collected. Food items are a mix of subsidized and unsubsidized products
Dawson et al. (2008)	Scotland	To study the availability of 'healthy' foodstuffs at affordable prices	A retailer survey in Scotland that considered availability and affordability of a basket of indicator healthy food items, termed the Healthy Eating Indicator Shopping Basket (HEISB). It comprised 35 items drawn from 5 major food groups. A census of HEISB availability in 466 stores was undertaken in a sample of locations that varied on dimensions of urban-rural and affluent-deprived
Cummins et al. (2010)	10 diverse areas of Scotland	To study whether fruit and vegetables were more expensive in different parts of Scotland	They sampled 310 stores located in 10 diverse areas of Scotland and data on the price and availability of a basket of 15 fruit and vegetable items were collected. The data were analysed to identify the influence of store type and neighbourhood deprivation on the price and availability of fruits and vegetables

Table 1. Continued

Study	Place	Motivation	Method
Hirsch et al. (2013)	Highland and Island communities of Scotland, namely: The research was held in three parts of remote rural Scotland: The Highlands, the Islands and remote southern Scotland	They study prices in rural areas as they affect the purchasing power and sustainability of communities in remote areas of Scotland	Their research considered 24 groups of residents in different parts of remote rural Scotland which provided what items households in their communities needed as a minimum. Pricing of the specified items was carried out in shops, through online or catalogue ordering and from other suppliers, following specifications by the groups of where residents would buy various types of items
Hirsch et al. (2016)	Highland and Island communities of Scotland, namely: The research was held in three parts of remote rural Scotland: The Highlands, the Islands and remote southern Scotland	They study prices in rural areas as they affect the purchasing power and sustainability of communities in remote areas of Scotland	Their research considered 24 groups of residents in different parts of remote rural Scotland which provided what items households in their communities needed as a minimum. Pricing of the specified items was carried out in shops, through online or catalogue ordering and from other suppliers, following specifications by the groups of where residents would buy various types of items
Dumfries and Galloway Citizen Advice Service (2015; 2017)	Dumfries and Galloway in Scotland	To study the cost of living in Dumfries and Galloway	They considered a list of basic grocery products, which they priced across different towns. Over the course of a week, and across the four historical counties of Dumfries and Galloway, they visited 38 supermarkets, minimarkets and village shops pricing the selected basket of products and each time they would choose the cheapest version on offer

Household Characteristics

The effect of household characteristics and the accessibility of healthy food has been studied by several authors, finding an important relationship. Thus, the basis for Tsang et al. (2007) research was existing evidence that some people in Australia do not have access to affordable, healthy foods. Their study showed that the cost of a healthy food basket (HFB) was lower in low-socioeconomic suburbs. Items in the HFB were found in most supermarkets surveyed; therefore, availability of healthy food at this geographical level was not a concern. However, the study highlighted the proportionately high costs of a healthy diet for families on welfare or on a single income based on average weekly earnings. In other terms, the main issue behind any affordability in the studied communities was low income and not high prices.

Palermo et al. (2008) studied the cost of healthy food and aimed to investigate the factors that influence the cost of food in rural Victoria, Australia. They found differences in the type of outlet being expensive to purchase the Victorian Healthy Food Basket (VHFB) at an independent store than at a supermarket chain.

Beaulac, Kristjansson, and Cummins (2009) carried out a systematic review of the presence of “Food deserts” (i.e., areas characterized by poor access to healthy and affordable food which may contribute to social and spatial disparities in diet and diet-related health outcomes). They found clear evidence for disparities in food access in the United States by income and race where area-level deprivation compounds individual disadvantage. However, they found that evidence for the existence of food deserts in other high-income nations is weak.

Regarding Scotland, the motivation behind Cummins et al. (2010) was that previous research suggested that fruits and vegetables were more expensive and less readily available in more deprived communities. However, it was based on small samples drawn from specific communities often located in urban settings and thus is not generalizable to national contexts. They found that neighborhood deprivation and store type did not significantly predict the price of a basket of fruit and vegetables within the sample, although baskets did decrease in price as store size increased. The highest prices were found in the smallest stores located in the most deprived areas.

Like Tsang et al. (2007), Ward et al. (2012) study was the fact that Australian consumers had to face increases in costs of basic food, and during the financial year 2007–2008. They found that compared with metropolitan areas, healthy food is more expensive in rural areas; costs

are even higher in more remote areas. However, they also found that the main factor behind affordability (or lack of it) were incomes.

Local Area Characteristics

Regarding the characteristics of local areas, the study by Palermo et al. (2008) also addressed the relationship between the cost of food and the location remoteness, but they did not find any association. In contrast, the study by Ward et al. (2012) found that Australian consumers face increases in costs of basic food, and during the financial year 2007–2008. They found that compared with metropolitan areas, healthy food is more expensive in rural areas; costs are even higher in more remote areas.

Pollard et al. (2014) research explored the impact of geographic factors on food pricing and quality in Western Australia. They found that the Healthy Food Access Basket costed 24 percent more in very remote areas than the major city with fruit being 32 percent, vegetables 26.1 percent, and dairy 40 percent higher. Higher prices did not correlate with higher quality with only 80 percent of very remote stores meeting all criteria for fresh produce compared with 93 percent in Perth. They concluded that food affordability and quality may deter healthier food choice in geographically isolated communities.

Ferguson et al. (2016) study had similar results as the aforementioned works on the relationship between food expensiveness and remoteness. They determined the average price difference between foods and beverages in remote indigenous community stores and capital city supermarkets and explore differences across products in Northern Territory, Australia. They found that products in remote areas were, on average, 60 percent and 68 percent more expensive than advertised prices for Darwin and Adelaide supermarkets, respectively.

Similar studies as those reviewed above have also been carried out in Scotland focusing on the availability of “healthy” foodstuffs at affordable prices. Dawson et al. (2008) carried out a retailer survey in Scotland that considered availability and affordability of a basket of indicator healthy food items, termed the Healthy Eating Indicator Shopping Basket (HEISB). They found large variations in price for the HEISB items across the stores and the survey areas. The total HEISB median price varied by store type. Basket price tended to rise with deprivation with a caveat of the lowest prices in the most deprived areas. Accessibility to a range of healthy food depends more on the presence of medium and large stores than being in a deprived or affluent area.

Dawson et al. (2008) investigated availability and prices in remote areas of Scotland of a basket of 35 items representative of a healthy diet. The

authors found that healthy food was available in general but observed large variations in prices depending on the level of social deprivation and the presence of large general stores. They did not find conclusive evidence of a “deprivation premium” and noted that format of local stores was the main driver of food affordability.

Different results from Cummins et al. (2010) come from Hirsch et al. (2013) who state that the sustainability of communities in remote areas of Scotland depends on people being able to afford to live there (Hirsch et al. 2013). Their results indicated that the budgets that households needed to achieve a minimum acceptable living standard in remote rural Scotland were typically 10–40 percent higher than elsewhere in the UK. These premiums were most modest for pensioners and greatest for single people and families supporting children.

Hirsch et al. (2016) updated their 2013 report by considering a new set of prices but without updating their baskets. They found that, in 2016, a minimum acceptable standard of living in remote rural Scotland typically requires between a tenth and a third more household spending than in urban parts of the UK. In general, the picture painted in their work was similar to the one in 2013, although the lower price of petrol and diesel significantly reduced the additional cost for people having to travel long distances, particularly regular travel for work. Moreover, the additional costs come from a range of sources. In particular, the costs of traveling, heating one’s home, and paying for goods and their delivery were much higher for many residents of the areas under review, especially those in the remotest areas.

Additional work was done by the Dumfries and Galloway Citizens Advice Service for their local authority, which corresponds to the south-west of Scotland. Researchers found that residents of smaller settlements in Dumfries and Galloway (Scotland), with limited access to public transport and a rural economy, often pay higher prices (Dumfries and Galloway Citizen Advice Service 2015; 2017). They found that a “poverty premium” exists in some of the towns (e.g., Upper Nithsdale); people in poorer areas are paying more for their essentials than those in the less disadvantaged parts of Dumfries and Galloway. Moreover, they found that a “rural premium”—sometimes in conjunction with the poverty premium—existed. In general, essential products costed more the further the distance from urban areas. This was also often the case with individual items, that is, the most expensive were to be found in rural areas.

Presence of Policy

Although not important for Scotland, the presence of policy should also be mentioned for completeness’ sake as it has been considered in

the literature. Thus, Naylor, Deaton, and Ker (2020) studied the pass-through rate of a subsidy carried out by the Canadian government to food retailers in the 25 remote communities in Nunavut through the Nutrition North Canada program. Their results suggest that most, if not all, of the subsidy is passed on to the consumer in lower food prices.

Type of Retail Outlet

Palermo et al. (2008) found differences in the type of outlet being more expensive to purchase the VHFB at an independent store than at a super-market chain. Similarly, Ferguson et al. (2016), who studied the average price difference for fresh products was half that of packaged groceries for Darwin supermarkets and more than 50 percent for food groups that contributed most to purchasing, found that the differences were due to the strategies employed by manufacturers and supermarkets, such as promotional pricing, and supermarkets' generic products lead to lower prices. These opportunities are not equally available to remote customers and are a major driver of price disparity.

The analysis by Bardenhagen et al. (2017) although not focused on prices, can also be considered in this review because it dealt with remote rural areas. Out-shopping (i.e., buying outside the local area), seasonality, and economic challenges were found to affect healthy food availability. Mid-sized independent stores were generally found to have a larger selection of healthy foods, but smaller rural groceries also have potential to provide fresh produce and increase food access.

Overall, this brief review of studies has highlighted the potential importance of remoteness for affordability, although with the presence of other mediating variables such as socioeconomic status of households, the type of available shops, passing-through of subsidies, seasonality. In addition, there are methodological issues with the comparisons; thus, Lewis and Lee (2016) undertook a systematic review to compare studies for monitoring Australian healthy food prices, and affordability studies. They considered national, state, regional, and local areas of Australia from 1995 to 2015. Their analysis demonstrated methodological differences regarding: the included foods; reference households; use of availability and/or quality measures; household income sources; store sampling methods; data collection protocols; analysis methods; and results, which let them conclude that "healthy" food price assessment methods used in Australia lack comparability across all metrics and most do not fully align with a "healthy" diet as recommended by Australian Dietary Guidelines.

Limitations of the aforementioned studies can also be found in the case of Hirsch et al. as they used aggregated expenditure categories in their comparison, which creates problems due to quality differences in

the products considered (Beatty 2010). Although they used 24 different groups, these baskets are still different from those of the individual households in rural areas. The latter point is of more significance in the case of the DGCAS study, because they use only one basket, which is modified to capture the cheapest version on offer. Dawson et al. (2008) considered a healthy basket that did not reflect the actual choice of consumers. More importantly, the majority of the studies were based on the survey of prices at local stores, without considering the effect of out-shopping on the actual prices of households' food baskets.

In this paper, we address these limitations in two ways. Firstly, we use household purchase data measuring the prices that are actually paid for food. In this way, the effect of out-shopping is considered in the analysis. Secondly, we use a price index introduced by Aguiar and Hurst (2007) that allows for comparison of prices among households taking into account the quality problem.

Methods and Data

Conceptual Framework and Testable Hypotheses

The paper investigates the impact of the characteristics of local areas on cost of their food basket in Scotland. For this study, food is more "expensive" if the cost of the actual household's food basket is higher than it would have been if the household bought exactly the same products at Scotland's average prices. The objective is to measure and explain the remoteness premium, defined as the difference in the average food expensiveness between remote areas and average value for Scotland.

Marketing theory describes modern food consumers as *basket shopper*, that is consumers that buy a large bundle of grocery goods choosing from a number of available stores in the area (Bell and Lattin 1998, Russo and Goodhue 2018). Because prices at competing stores are heterogeneous (due to differences in procurement efficiency or pricing and promotion strategies) consumers may save on their grocery expenditure by purchasing each item in the basket from the store and selling it for the lowest price. This mix-and-save strategy is often referred to as *cherry-picking* behavior (Lal and Rao 1997). According to Bliss (1988), modern consumers face a trade-off between the savings from cherry-picking behavior and the cost of traveling to multiple stores (including transportation costs and opportunity cost of time). As the number of visited stores increases, the savings are larger, but cost of traveling increases. The solution of this trade-off depends on individual preferences and determines the consumer's shopping strategy, that is the frequency of shopping trips, the number and type of stores to travel to, and the size of purchase in each store (Kahn and Schmittlein 1989).

According to marketing theory, consumer's expenditure for a given basket of goods depends on individual preferences over three factors: (1) the distributions of prices at available stores, (2) distance between stores and transportation costs, (3) opportunity cost of time (shopping at one store once a week takes less time than shopping at many stores every day). This conclusion from the literature shows a weakness in previous studies about food prices in rural areas. By collecting prices at local stores, these studies consider only one of the three factors affecting consumer expenditure and they ignore the possible implications that living in remote areas may have on consumers' shopping strategies. For example, high prices in the remote area stores may have limited impact, if transportation prices are low and consumer can shop in urban stores. On the other hand, if cherry-picking is impossible because of high transportation costs, even relatively small price differences may have impact on consumer expenditure.

In order to overcome this limitation, this study considers Scottish consumers' actual expenditure for food. In this way, the observed purchasing prices for a given basket are the results of both price distribution and shopping strategy, and a more meaningful comparison between remote and non-remote areas is possible.

The empirical challenge in this approach is the disentanglement of the factors determining the difference in expenditure between areas. Simply observing expenditure, it is not possible to establish whether the difference is due to store price distribution, limitations in shopping strategy (for example, high transportation costs preventing cherry-picking behavior) or a combination of both. For this reason, two econometric models were developed. In the first one, expensiveness of food basket is explained taking shopping strategy as given. This model compares the expensiveness of the basket for households with similar shopping strategies and identifies systematic differences between remote and non-remote areas. In the second econometric model, differences in shopping strategies are investigated between households in remote and non-remote areas. The combined information from the two models provides a measure of effect of each factor on the remoteness premium.

The conceptual framework supporting the regressions was developed considering data limitations. Data about the stores that are accessible to individual households, their prices and the related transportation costs were not available. Shopping strategy, purchases (quantity and prices), household characteristics and location are observable and are used to approximate the unobservable variables. [Figure 1](#) summarizes the empirical conceptual approach used in the study. It illustrates two possible types of effects of the characteristics of the local area (remote vs.

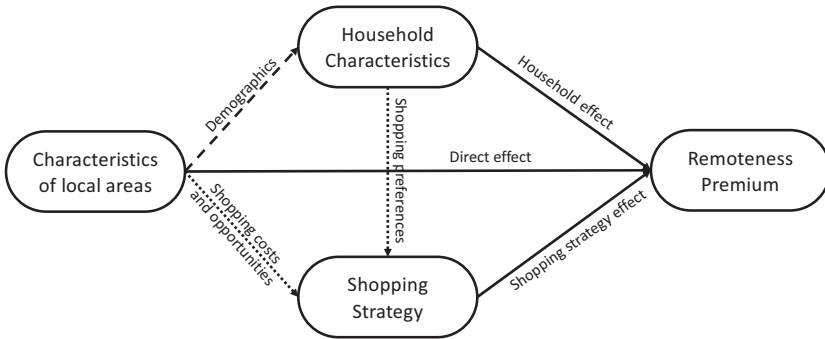


Figure 1. Factors Considered to Analyze Difference in Prices.

non-remote) on remoteness premium: direct effects and indirect effects through the influence on consumers' demographic characteristics and their shopping strategy.

The direct effect of remoteness may include transportation and logistics costs for firms due to inferior infrastructure or higher cost of fuel (e.g., Mendoza 2011), reduced local competition among retailers leading to oligopoly prices (e.g., Clarke 2000; Guy 1991). For example, it might be expected that retailers selling in remote areas face in higher logistics costs and reduced competition compared to those operating in large cities. Consequently, consumers living in remote areas may face higher prices at least for some categories of products than average Scotland. Other direct effects may include social deprivation, or cultural factors (such as different perceptions of food or social values attached to food, e.g., Pieniak et al. 2009, or McIntyre and Rondeau 2011).

Households' characteristics are a proxy for the effects that consumer preferences may have on the expensiveness of the food basket. For example, household's per capita income is expected to be positively correlated with food expensiveness, because low-income consumers may be more price-sensitive. Similarly, demographic factors, such as age or gender, might influence food expensiveness by affecting consumers' price perception and purchasing behavior (e.g., Janiszewski and Lichtenstein 1999, Munnukka 2006). Because the demographic structure of population in remote areas differs from urban and other non-remote areas, an indirect effect of the characteristics of local areas on the remoteness premium exists via the household effect.

Consumers' decisions about the shopping strategy may be influenced by the characteristics of the local areas. Transportation costs in remote areas may be higher (due to longer distances, inferior public services and infrastructure or fuel prices) and access to major retail chains may

be limited (Dawson et al. 2008). These factors may affect the consumers' ability to engage in cherry-picking strategies and therefore may result in higher expensiveness of the food basket.

The conceptual framework suggests three testable hypotheses. The econometric analysis in the following section addresses them. The first hypothesis concerns the existence of a remoteness premium once possible cherry-picking behavior is considered. Existing surveys of store prices may overestimate the remoteness premium because they do not consider the consumer ability to cherry-pick lowest prices. The hypothesis is tested by computing the remoteness premium using actual purchasing prices, instead of store prices. The second hypothesis concerns the existence (and magnitude) of the three drivers of the remoteness premium (Direct, Household, and Shopping Strategy effects in Figure 1). A regression at household level of the food basket expensiveness on variables measuring the three effects is used to test this hypothesis. The third hypothesis concerns the existence of indirect effects of remoteness on shopping strategy. A system of simultaneous equations is estimated to measure the effects of a change in variables describing local area and household characteristics on the shopping strategy.

The results of the tests are used in Section 5 to illustrate the contribution of each variable to the composition of the remote premium.

Measuring Remoteness Premium

In order to provide a meaningful comparison of food expenditure, monthly price indexes by household following Aguiar and Hurst (2007) approach were computed. Using this index, products were compared to like avoiding quality problems. In other terms, Aguiar and Hurst constructed a price index in a way that allows cross-household comparisons despite the fact that households' shopping baskets differ. Using these indexes, it was possible to respond to the question whether the actual purchases bought by each household were more expensive than the cost of their purchased basket evaluated at the Scottish average prices. The index is briefly presented below for completeness's sake. Let us define:

$p_{i,t}^j$ = Price paid for good i , by household j at time t .

$q_{i,t}^j$ = Quantity purchased of good i , by household j at time t .

X_m^j = Monthly expenditure by household j .

They are defined as in (1) to (3):

$$X_m^j = \sum_{i \in I, t \in m} p_{i,t}^j q_{i,t}^j \tag{1}$$

$$\bar{q}_{i,m} = \sum_{j \in J, t \in m} q_{i,t}^j \tag{2}$$

$$\bar{p}_{i,m} = \sum_{j \in J, t \in m} p_{i,t}^j \left(\frac{q_{i,t}^j}{\bar{q}_{i,m}} \right) \tag{3}$$

If the household pays the average price for the same basket of goods, the cost of the bundle would be (4):

$$Q_m^j = \sum_{i \in I, t \in m} \bar{p}_{i,m} q_{i,t}^j \tag{4}$$

The price index for the household (5) is the ratio of expenditure at actual prices divided by the cost of the bundle at the average price:

$$\tilde{p}_m^j \equiv \frac{X_m^j}{Q_m^j} \tag{5}$$

The index is normalized by dividing through the average price index across households within the month, ensuring that for each month the index is centered around one (6):

$$p_m^j \equiv \frac{\tilde{p}_m^j}{\frac{1}{J} \sum_{j'} \tilde{p}_m^{j'}} \tag{6}$$

As pointed out by Aguiar and Hurst, the above price index shares the typical feature (as with Laspeyres and Paasche indices) that the basket of goods is held constant as the prices vary between numerator and denominator. To the extent that relative price movements induce substitution between goods, there is no reason to expect that the household would keep its basket constant. As noted, given the fact that the goods are not aggregated, that is, the prices are for identical goods, the price index does not reflect differences in quality. For convenience, the value $p_m^j \times 1,000$ is referred as Aguiar and Hurst Expenditure Index (AHEI, hereafter).

Because AHEI uses actual purchases, it incorporates the effects of possible cherry-picking behavior. The purchasing prices in AHEI are determined by store price distribution and by household's shopping

strategies. By comparing the outcome of AHEI computations and the results of store price survey, it is possible to assess the importance of cherry-picking strategies in remote areas.

Explaining the AHEI Values

A regression of the index AHEI on a set of explanatory variables was considered. Following the conceptual framework in section, the regression equation is specified as (7):

$$\text{AHEI}_i = \alpha + \sum_q \beta_q L_{q,i} + \sum_r \gamma_r H_{r,i} + \sum_s \delta_s S_{s,i} + \varepsilon_i \quad (7)$$

where α , β , γ , and δ are parameters to be estimated and ε_i is a heteroskedastic, normally distributed error term. H_r , S_s , and L_q are variables describing household i 's characteristics, their shopping strategies, and the characteristics of the area they live in. By adding to the L_q variables and indicator for remote areas, it is possible to estimate the expected difference in the AHEI for households living in such areas.

It must be noted that the estimate will be conditional to the realizations of all other variables. This point is of particular importance in the investigation because local area characteristics might affect the household's shopping strategy. In order to investigate this point further, a regression of the shopping characteristics S_s on local area and household characteristics was run. Because the shopping strategy is jointly determined, regressions of S_s variables were estimated as a system of equations of the form (8):

$$S_{s,i} = \zeta_s + \sum_q \theta_{q,s} L_{q,i} + \sum_t \xi_{t,s} H_{t,i} + \eta_{i,s} \quad (8)$$

where ζ , θ , and ξ are regression parameters to be estimated in each equation and $\eta_{i,s}$ is the error term. Using this two-step approach, it was possible to break the remoteness effect into two components: a direct impact on expensiveness and indirect impact through changes in shopping behavior.

Data and Variables Specification

The main data source was Kantar Worldpanel database for Scotland, which 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. The dataset is composed of 5,252 households for the years 2017 and 2018 (specifically, 2,616 in

2017 and 2,636 in 2018). The 2 years were pooled in a single dataset. The dataset not only allowed us to compute the average annual AHEI for each household in the dataset but also provided information about the characteristics of the households in terms of age of the Main shopper, their gender, number of children, number of trips to shops and in what shops the purchases were made.

In order to obtain information regarding the characteristics of the local areas the households lived in, the dataset was augmented with information from the Scottish Neighborhood Statistics regarding the 2016 Scottish Index of Multiple Deprivation (SIMD).¹ Based on this ancillary information, each observation was attributed to one of the following groups representing six types of local areas: remote rural areas (RRA), remote small towns (RST), accessible rural areas (ARA), accessible small towns (AST), large urban areas (LUA), and other urban areas (OUA).² Weights for the households were constructed based on three variables: local authorities, areas, and the 2016 SIMD. All data presented in the paper were weighted to ensure that estimates are representative of Scottish households.

The model variables were specified as follows: The characteristics of local areas L_q were summarized into three groups of variables, describing household access to discount stores, local deprivation and the degree of remoteness and rurality of the area where the household live in. [Table 2](#) reports descriptive statistics (mean and standard deviation) of the variables in the dataset.

A binary variable identifies households that did not access discount stores (DISCOUNT).³ Remote rural areas and remote small towns reported low shares of household that used discount stores (0.89 and 0.93, respectively, compared to Scotland's average of 0.96). Following Dawson et al. (2008), expenditure for the basket is expected to be higher in these areas. The presence of supermarkets or discount stores was not observable in the dataset and was approximated setting DISCOUNT equal to 1 if the household shopped at least once (regardless of the expenditure) at a discount store. The proxy was built under the assumption that, if the household never shopped at any discount store (not even once, not even for the smallest expenditure), either this type of stores was not available in the area, or some other constraint was binding. However, it is possible that a discount store was available, but the household simply did not shop there.

A set of five variables (from S1 to S5) reports the quintiles of the 2016 Scottish Index of Multiple Deprivation (SMD) for the neighborhood the household is located in. Finally, six variables identifying the areas, measuring the "place effect," that is, any residual effect of local characteristics that were not captured by the other variables.

Table 2. Descriptive Statistics

		Urban/Rural Areas							Scotland
Variable	Description	Large Urban Areas (LUA)	Other Urban Areas (OUA)	Access, Small Towns (AST)	Access, Rural Areas (ARA)	Remote Small Towns (RST)	Remote Rural Areas (RRA)		
	Sample size (n)	1,595	2,005	473	641	199	339	5,252	
AHEI	Population ($n/1000$)	1,680.9	1,628.0	356.7	460.8	155.9	264.0	4,546.2	
	Food expenditure index	μ 999.35 σ 15.68	μ 999.28 σ 14.27	μ 1000.23 σ 15.37	μ 1001.22 σ 12.79	μ 1003.09 σ 17.68	μ 1004.29 σ 18.27	μ 1000.00 σ 15.19	
Local area characteristics	Access to discount stores 1 if access; 0 otherwise	μ 0.96 σ 0.20	μ 0.96 σ 0.19	μ 0.95 σ 0.21	μ 0.95 σ 0.21	μ 0.93 σ 0.25	μ 0.89 σ 0.31	μ 0.96 σ 0.21	
S1	First SIMD quintile 1 if SIMD16 = 1; 0 otherwise	μ 0.29 σ 0.46	μ 0.24 σ 0.43	μ 0.10 σ 0.31	μ 0.03 σ 0.18	μ 0.12 σ 0.32	μ 0.03 σ 0.16	μ 0.21 σ 0.41	
S2	Second SIMD quintile 1 if SIMD16 = 2; 0 otherwise	μ 0.18 σ 0.38	μ 0.27 σ 0.44	μ 0.19 σ 0.40	μ 0.15 σ 0.36	μ 0.27 σ 0.45	μ 0.12 σ 0.32	μ 0.21 σ 0.41	
S3	Third SIMD quintile 1 if SIMD16 = 3; 0 otherwise	μ 0.14 σ 0.35	μ 0.18 σ 0.38	μ 0.23 σ 0.42	μ 0.27 σ 0.45	μ 0.30 σ 0.46	μ 0.50 σ 0.50	μ 0.20 σ 0.40	
S4	Fourth SIMD quintile 1 if SIMD16 = 4; 0 otherwise	μ 0.15 σ 0.35	μ 0.14 σ 0.35	μ 0.21 σ 0.41	μ 0.44 σ 0.50	μ 0.22 σ 0.41	μ 0.33 σ 0.47	μ 0.19 σ 0.40	
S5	Fifth SIMD quintile 1 if SIMD16 = 5; 0 otherwise	μ 0.24 σ 0.43	μ 0.17 σ 0.38	μ 0.26 σ 0.44	μ 0.11 σ 0.31	μ 0.09 σ 0.29	μ 0.03 σ 0.17	μ 0.19 σ 0.39	

Table 2. Continued

		Urban/Rural Areas						
Variable	Description	Large Urban Areas (LUA)	Other Urban Areas (OUA)	Access. Small Towns (AST)	Access. Rural Areas (ARA)	Remote Small Towns (RST)	Remote Rural Areas (RRA)	Scotland
Household characteristics	AGE	46.41	46.94	48.91	48.67	48.30	51.85	47.40
	Household	μ						
	Household	σ	13.14	13.51	13.87	14.19	13.05	13.54
FEMALE	Household Main	μ	0.73	0.81	0.76	0.69	0.70	0.72
	Shopper 1 if female, 0 otherwise	σ	0.44	0.39	0.43	0.46	0.46	0.45
CHILD	Number of children in the household	μ	0.61	0.68	0.62	0.62	0.62	0.56
	Married status of Main S, 1 if married, 0 otherwise	σ	0.82	0.93	0.94	0.97	1.05	0.91
MARRIED	Married status of Main S, 1 if married, 0 otherwise	μ	0.76	0.72	0.78	0.83	0.74	0.78
		σ	0.38	0.43	0.41	0.37	0.44	0.41
INGLOW	Household income 1 if < £30K; 0 otherwise	μ	0.46	0.53	0.42	0.60	0.61	0.49
		σ	0.50	0.50	0.49	0.49	0.49	0.50
Shopping strategy	TRIPW	μ	2.29	2.34	2.18	2.05	1.99	2.27
		σ	1.17	1.25	1.20	1.07	0.83	0.91
NSTORE	N. of stores visited in the period	μ	8.65	8.55	8.48	7.60	6.97	8.44
		σ	4.22	4.21	4.18	4.29	3.85	3.80
HHI	Expenditure concentration index	μ	0.43	0.46	0.45	0.50	0.52	0.45
		σ	0.22	0.24	0.24	0.23	0.21	0.24

Note: μ stands for the mean and σ for the standard deviation.

Household characteristics were measured using several social and demographic variables. Moreover, heterogeneity of preferences was approximated by means of information about the age (AGE variable), gender (FEMALE variable), and marital status (MARRIED) of the Main Shopper⁴ and the number of children in the household (CHILD). Low disposable income was approximated by a binary variable identifying households with a total household income lower than £30,000 (INCLLOW). It is expected that households with low-income shop more actively and pay less for their baskets than others, keeping all other variable constant.

Shopping behavior was measured using three variables: the average number of weekly trips for grocery shopping in the year (TRIPW), the number of different retail chains that the consumer visited in the year (NSTORE), and a concentration index of expenditure by household among different retail chains (HHI).⁵ The three variables characterize a broad range of shopping behavior. For example, high values of TRIPW, NSTORE, and low values of HHI identify consumers shopping actively in different stores. Instead, an opposite realization of low TRIPW, NSTORE, and high HHI values define a loyal, one-stop shopper who prefers to buy food from a usual store in a limited number of trips.

A comparison of mean values found that the average values of variables TRIPW and NSTORE are significantly lower in remote areas (remote rural areas and remote small towns) than in other areas (95 percent confidence level). Instead, the average HHI is significantly higher in remote than in non-remote areas. Such differences in the average values of shopping behavior variables suggest that households in remote areas might face conditions limiting their ability to shop actively.

Results and Discussion

The results confirmed that average per capita food expenditure (PCFE)⁶ was higher in remote Scottish areas than in other parts of Scotland. The point estimate of the average difference was 149.2 pounds per person per year (the 95 percent confidence interval was [18.8, 279.7]), that is 8.8 percent of the average per-person food expenditure in remote areas. The data reported differences in average expenditures across local areas. [Table 3](#) reports the descriptive statistics for PCFE and the percent pairwise difference between local areas.

Remote rural areas exhibited a higher average PCFE than other areas. On average, households in remote rural areas spent 15 percent more on food than those in accessible small towns, 10 percent more than those in large urban areas and in accessible rural areas. Households in remote small towns exhibited higher per-person food expenditure than those in accessible small towns. The data did not support the hypothesis of a difference in the average PCFE between remote small towns and remote rural areas.

Table 3. Per Capita Food Expenditure (PCFE) by Local Areas: Descriptive Statistics and Percent Pairwise Differences

Local Areas	PCFE		Percent Pairwise Difference in Average PCFE								
	Mean (£)	Standard Dev (£)	Between Local Areas								
			Large Urban Areas (LUA) (%)	Other Urban Areas (OUA) (%)	Access. Small Towns (AST) (%)	Access. Rural Areas (ARA) (%)	Remote Small Towns (RST) (%)	Remote Rural Areas (RRA) (%)			
LUA	1,518	1,219			4.7	-0.8	-10.3				
OUA	1,580	1,316	3.9		8.4	3.2	-6.0				
AST	1,447	1,247	-4.9	-9.2		-5.7	-15.8				
ARA	1,530	1,167	0.8	-3.3	5.4		-9.5				
RST	1,675	1,210	9.4	5.7	13.6	-8.7					
RRA	1,694	1,390	10.4	6.7	14.6	9.7	1.1				

Note: Bold font indicates differences in average PCFE that are statistically significant at 95 percent confidence level, italic font indicates 90 percent confidence.

The difference between remote rural and accessible rural areas supported the conclusion that the expenditure difference was associated with remoteness, and it was not due to the rural characteristic of the area. Comparing PCFE between areas does not account for differences in the composition of the food basket and Table 3 does not explain whether difference in expenditure was driven by higher prices (i.e., an affordability problem) or by different purchase decisions (i.e., an availability problem).

In order to address the study question, the AHEI for each household in the panel was computed. Recall that the index compares the cost of the actual food basket with cost of buying exactly the same basket at prices that were equal to Scotland’s average prices for each product. Note that for this Kantar Worldpanel data provide information at the actual product level (e.g., new potatoes of a specific variety as seen in a retailer) in contrast to category level (e.g., potatoes). In this way, any difference is determined by the relative prices alone. This process was used to break the difference in expenditure into two components: a price effect, driven by the difference in the price of goods, and a basket effect, driven by the choice of different goods.

Figure 2 compares the quartile distribution of the AHEI by type of local area. Despite of data dispersion, the median values in the six areas

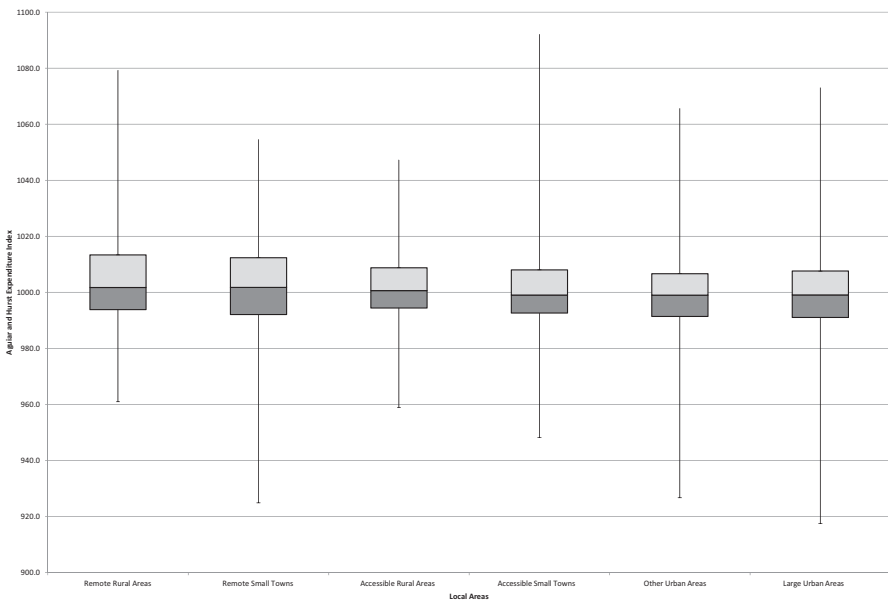


Figure 2. Box-Plot of the AHEI by Local Area. Scotland Average = 1,000.

are similar, with all values within 1 percent below or above the threshold value of 1,000.

Table 4 reports the mean and standard deviation of the AHEI by local area, the 95 percent confidence interval of the percent pairwise difference in the AHEI between areas and of the percent remoteness premium (that is the difference between the average AHEI in the area and the reference value 1,000).

A set of *t*-tests rejected the null hypothesis of no premium in four areas at a 95 percent confidence level in four areas. On average, households in accessible rural areas, remote small towns, and remote rural areas paid more for their food basket than they would have paid at Scotland average prices (respectively, 0.1, 0.3, and 0.4 percent), which, however, are not economic meaningful. Other urban areas exhibited a negative and statistically significant premium, which means that they paid less than average Scotland prices.

The estimates of the remoteness premium in this study are lower than the ones found in previous studies. The difference with existing literature can be explained by two considerations.

Firstly, AHEI uses actual purchases instead of a pre-determined basket (as the “acceptable standard of living” in Hirsch et al. 2013). Because essential goods are more expensive in rural Scotland (Dumfries and Galloway Citizen Advice Service 2015; 2017), the price difference on a minimal basket of necessities might be higher on average than the one on a more realistic basket. Secondly, AHEI considers the effects of households’ shopping strategies while store-price surveys do not. A possible explanation for the difference in estimates may be that prices are higher in remote areas (as indicated by store-price surveys) but households in remote areas buy only part of their food basket at local stores (out-shopping, Bardenhagen et al. 2017). However, the dataset does not provide the information that are needed to test this explanation and further research is needed to assess the ability of consumers in remote area to shop at stores in non-remote areas at lower prices.

Measuring the Effect of Some Variables on the AHEI

To measure the effect of some variables highlighted in the literature, the household-level AHEI was regressed on a vector of variables describing characteristics and shopping strategy of the household and local area characteristics, such as social deprivation and access to discount stores. A “place effect,” summarizing all local area effects that are not captured by other variables, was modeled with binary variables identifying the local areas; the base of the dummies was Accessible Small Towns. A binary variable identifying data collected in 2018 was added to the regression

Table 4. AHEI by Local Area—Descriptive Statistics and Confidence Intervals of Pairwise Differences

Local Areas	AHEI Mean	Std. Dev.	95 Percent Confidence Intervals of Percent Pairwise Difference in Average AHEI						
			Large Urban Areas (LUA) (%)	Other Urban Areas (OUA) (%)	Accessible Small Towns (AST) (%)	Accessible Rural Areas (ARA) (%)	Remote Small Towns (RST) (%)	Remote Rural Areas (RRA) (%)	Remoteness Premium (%)
LUA	999.4	15.7	-	[-.06, .08]	[-.17, .01]	[-.26, -.10]	[-.48, -.26]	[-.60, -.38]	[-.14, .02]
OUA	999.3	14.3	[-.08, .06]	-	[-.17, -.01]	[-.26, -.12]	[-.48, -.29]	[-.59, -.41]	[-.13, -.01]
AST	1000.2	15.4	[-0.01, .17]	[.01, .17]	-	[-.22, .02]	[-.47, -.11]	[-.57, -.25]	[-.12, .16]
ARA	1001.2	12.8	[.10, .26]	[.12, .26]	[-.02, .22]	-	[-.34, -.04]	[-.45, -.17]	[.02, .22]
RST	1003.1	17.7	[.26, .48]	[.28, .47]	[.11, .47]	[.04, .34]	-	[-.33, .09]	[.06, .55]
RRA	1004.3	18.3	[.38, .59]	[.40, .59]	[.24, .57]	[.17, .45]	[-.09, .33]	-	[.23, .62]
Scotland	1000.0	15.2	[-.02, .14]	[.01, .13]	[-.16, .12]	[-.22, -.02]	[-.56, -.06]	[-.62, -.24]	-

Note: Bold font indicates differences in average PCFE.

to control for year-specific factors.⁷ Table 5 reports the results of the regression.⁸

On average, and keeping all other factors constant, shopping strategies were found to affect the AHEI for food. As the number of weekly trips increases (TRIPW), the expected value of AHEI decreases by 2.1 points per trip. This indicates that frequent shoppers are more likely to benefit from the variation in promotions and sales over time (same store) and space (different stores). Concentration of expenditure in one chain (HHI), on average, is associated with higher values of AHEI. Consumers buying most of their food from a single retailer are less likely to benefit from sales from different stores. Instead, households spreading their purchases across multiple retail chains can compare prices and select the best deal, with a direct impact on the food expenditure. After controlling for expenditure concentration, the number of visited stores does not affect the AHEI.

Household characteristics were found to have a statistically significant effect on AHEI; on average, women pay less than men for the same food basket, keeping all other variable constant. The AHEI on average decreases with the number of children in the household. The coefficient of the MARRIED is positive supporting the conclusion that married Main Shoppers pay more for the food basket, on average. Households with income lower than £30,000 on average pay less than others for the same food basket (after controlling for local social deprivation). The relationship between AHEI and age was non-linear. Main Shoppers in early thirties pay the lowest prices, and younger and older people pay more for their food basket.⁹

Area characteristics had effects on the food expensiveness (Table 5). An *F*-test on the joint significance of the coefficients of TRIPW, NSTORE, and HHI rejects the null hypothesis of all coefficients jointly equal to zero (*F*-stat: 66.750, *p*-value <0.001). On average, access to discount stores is expected to lower AHEI by 6.1 points. This finding confirms the results by Dawson et al. (2008) regarding the importance of access to low-price retail formats. However, available store format is not the only characteristic of local area affecting expenditure. Households located in highly deprived areas were associated with higher values of the AHEI index.¹⁰ The index value of observations belonging to areas in the fifth quintile of the SIMD16 on average was 3.0 points higher than the one of households in the first quintile. Remote rural areas exhibited a higher intercept parameter that was higher than urban areas and accessible small towns. The data did not support the existence of other fixed effects.

The regression parameters from Table 5 were used to approximate the contribution of each variable to the area premium. Table 6 and Figure 3

Table 5. Weighted Regression of AHEI on Household Shopping Strategy and Characteristics, Local Area Characteristics

Variable	Coefficients	White's robust Std. err.	t-statistics	P-value	Elasticity at means
Shop. Strat.					
TRIPW	-2.066	0.279	-7.410	0.000	-0.005
NSTORE	0.124	0.087	1.420	0.154	0.001
HHI	7.165	1.394	5.140	0.000	0.003
AGE	-0.238	0.114	-2.090	0.037	-0.011
AGE2	0.004	0.001	3.360	0.001	0.009
FEMALE	-1.054	0.523	-2.010	0.044	-0.001
CHILD	-0.719	0.253	-2.840	0.005	-0.001
MARRIED	1.996	0.520	3.840	0.000	0.000
INLOW	-1.923	0.480	-4.010	0.000	-0.001
DISCOUNT	-6.130	1.566	-3.920	0.000	-0.006
S2	0.530	0.684	0.770	0.439	0.000
S3	1.342	0.692	1.940	0.052	0.000
S4	1.652	0.832	1.980	0.047	0.000
S5	2.986	0.740	4.030	0.000	0.000
LUA	-0.466	0.843	-0.550	0.581	-0.000
OUA	-0.124	0.802	-0.150	0.877	-0.000
ARA	0.681	0.899	0.760	0.449	0.000
RST	2.370	1.714	1.380	0.167	0.000
RRA	2.786	1.244	2.240	0.025	0.000
YEAR2018	-0.142	0.446	-0.320	0.751	-0.000
Constant	1007.489	3.497	288.090	0.000	1.009
N. Observations	5,252				
R ²	0.094				
F (20, 5,231)	22.050*				

Note: * stands for statistically significant at 95 percent.

Table 6. Contributions of Variables to Area Premia

Factors	Large Urban Areas (LUA)	Other Urban Areas (OUA)	Accessible Small Towns (AST)	Accessible Rural Areas (ARA)	Remote Small Towns (RST)	Remote Rural Areas (RRA)
Shopping strategy	-0.20	-0.07	0.14	0.14	0.70	0.85
Household characteristics	0.13	-0.29	-0.16	0.21	0.02	0.22
Access to discount stores	-0.03	-0.05	0.02	0.02	0.14	0.39
Social deprivation	-0.01	-0.12	0.29	0.23	-0.08	0.11
Place effect	-0.53	-0.18	-0.06	0.62	2.31	2.73
Area premium	-0.65	-0.72	0.23	1.22	3.09	4.30

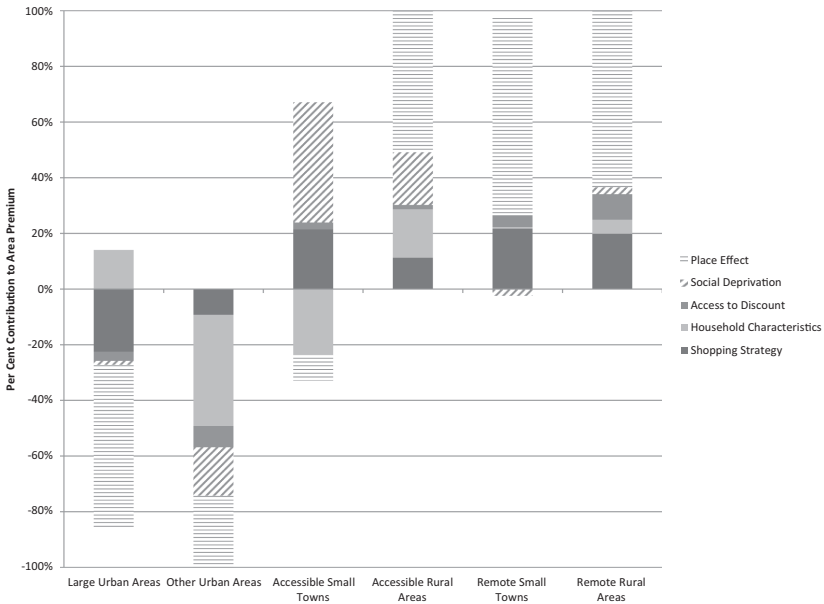


Figure 3. Percentage Contribution to Area Premia.

report the results of the calculations (in absolute values and percentage, respectively). The contribution is calculated by multiplying the difference between the local area and Scotland’s mean values of each variable by the appropriate regression coefficients.¹¹

As shown in [Figure 3](#), the premium in remote small town is determined by the place effect (75 percent of total premium) and the shopping strategy effect (23 percent). In remote rural areas, the place effect accounts for 63 percent of the premium, shopping strategy effect for 20 percent. Noticeably access to discount stores is a minor driver: it contributes for 0.04 and 0.09 percent in remote small towns and remote rural areas, respectively. Although this variable has a major impact at the household level ([Table 4](#)), the aggregate contribution is tempered by the limited number of households who did not access discount stores. The effect of social deprivation is limited in all local areas but accessible small towns.

Simulating the Effect of Social and Economic Trends

The results of the regression can be used to evaluate the possible effects of existing social and economic trends on food expensiveness in remote areas. In particular, the issues of population aging, and decreasing social deprivation (due to local development) and improving access to discount stores are found of particular interest.

The impact evaluation provided by decomposition of area premia presented in [Table 6](#) can be further elaborated by considering the possibility that local area or household characteristics may affect the shopping strategy. This evaluation of the indirect effect requires regressions of the shopping strategy variables on area dummies and household characteristics. The results are presented in [Table 6](#). The estimation used weighted three-stage least square to account for the joint determination of the shopping strategy variables.¹²

The estimation did not provide conclusive evidence of an effect of area characteristics on shopping strategy, except for place effects in remote rural areas and other urban areas. In contrast, households' characteristics influence the shopping behavior. Thus, elder consumers, on average, shop more often, visit more stores, and concentrate their expenditure more.

Using the estimations of [Tables 4](#) and [5](#), three scenarios dealing with the effect on food expensiveness were simulated, namely: scenario A consisted of a unit change in the average age of Main Shoppers in the local area (i.e., aging population), scenario B concerns new opening of discount stores in remote areas (or promoting access where already in place) and scenario C refers to reduction of social deprivation.

The simulations were carried out as follows: let ΔX be the change on variable X ; $\beta_Y(X)$ denotes the coefficient of variable X in regression Y (e.g., that $\beta_{\text{TRIPW}}(\text{AHEI})$ is the coefficient of variable TRIPW in the regression of AHEI, $\beta_{\text{AGE}}(\text{TRIPW})$ is the coefficient of variable AGE in the regression of TRIPW). Then, a first-order approximation of the effect on AHEI of a change on the variable X was estimated by $\Delta X \cdot \beta_X(\text{AHEI})$ and the first order approximation of the indirect effect (through a change in shopping strategy) was $\sum \Delta X \cdot \beta_X(Z) \cdot \beta_Z(\text{AHEI})$ where $Z = \{\text{TRIPW}, \text{NSTORE}, \text{HHI}\}$.

As the regression models included a quadratic term for the variable AGE, the marginal effect of a unit change in age on the variable Y compute as $\beta_{\text{AGE}}(Y) + 2 \cdot \beta_{\text{AGE}^2}(Y) \cdot \text{AGE}$. The results of calculation are presented in [Table 7](#). Scenarios B and C make the values of the variables DISCOUNT and S2 to S5 in remote areas equal to Scotland's average values (from [Table 3](#)), so that ΔX is the difference between Scotland's average and the local area average.

As shown in [Table 8](#), aging of population in remote areas is expected to determine an increase in the remoteness premium. Elder households shop more frequently, visit more stores on average but concentrate their food expenditure more than young ones. Frequent shopping was associated with lower food expensiveness, while expenditure concentration was associated with higher prices for the food basket. The overall result is an indirect effect of aging that is close to zero because the effects of the changes in shopping strategy are relatively small and cancel out each

Table 7. Weighted 3SLS Regression of Shopping Strategy Variables

Variables	Number of Shopping Trips (TRIPS)			Number of Visited Store (NSTORE)			Expenditure Concentration (HHI)		
	Coef.	Std. Err.	PVal.	Coef.	Std. Err.	PVal.	Coef.	Std. Err.	PVal.
TRIPW	-0.008	0.031	0.795	0.052	0.501	0.918	-0.110	0.021	0.000
NSTORE	-2.764	0.519	0.000	-16.474	1.386	0.000	-0.043	0.003	0.000
HHI	0.016	0.007	0.025	0.105	0.024	0.000	0.006	0.001	0.000
AGE	0.000	0.000	0.265	-0.001	0.000	0.014	0.000	0.000	0.278
AGE2	0.086	0.033	0.010	0.519	0.114	0.000	0.031	0.007	0.000
FEMALE	0.077	0.015	0.000	-0.014	0.067	0.838	0.008	0.004	0.034
CHILD	0.002	0.034	0.943	-0.351	0.117	0.003	-0.014	0.007	0.049
MARRIED	0.060	0.026	0.020	-0.037	0.100	0.709	0.005	0.006	0.384
INLOW	0.086	0.093	0.356	-0.046	0.346	0.895	0.008	0.021	0.705
DISCOUNT	-0.056	0.039	0.148	-0.036	0.145	0.803	-0.008	0.009	0.373
S2	0.031	0.041	0.448	0.192	0.148	0.196	0.012	0.009	0.204
S3	0.019	0.041	0.648	-0.048	0.151	0.753	0.000	0.009	0.990
S4	-0.052	0.041	0.202	-0.007	0.151	0.966	-0.006	0.009	0.507
S5	0.045	0.050	0.375	-0.104	0.186	0.574	0.001	0.011	0.956
LUA	0.158	0.050	0.002	0.287	0.196	0.143	0.030	0.011	0.009
OUA	-0.106	0.060	0.078	-0.150	0.224	0.503	-0.018	0.013	0.178
ARA	-0.064	0.081	0.425	0.002	0.297	0.995	-0.007	0.018	0.694
RST	-0.192	0.073	0.009	-0.674	0.272	0.013	-0.050	0.016	0.002
RRA	-0.018	0.025	0.464	0.003	0.091	0.976	-0.002	0.006	0.730
YEAR2018	2.418	0.429	0.000	12.097	1.387	0.000	0.778	0.039	0.000
Constant	0.35			0.37			0.13		
R^2	1396.80*			2174.91*			1446.38*		

Note: * stands for statistically significant at 95 percent. Weighted three stages least squares were used to estimate the regressions as a system.

Table 8. Effect of Population Aging, Improved Access to Discount Stores and Reduction of Social Deprivation on Remote Areas AHEI

	Scenario A		Scenario B		Scenario C	
	Population Aging (1 Year)		Improving Access to Discount Stores		Reducing Social Deprivation	
	RST	RRA	RST	RRA	RST	RRA
Direct effect	0.132	0.159	-0.184	-0.429	0.083	-0.109
Indirect effect	-0.007	-0.009	-0.005	-0.012	-0.007	-0.031
Total	0.125	0.150	-0.189	-0.441	0.076	-0.139

Note: Scenario A considers the effects of a one-year increase in average age in remote areas, scenarios B and C the effects of an exogenous change in the variables DISCOUNT and S2 to S5 (respectively) such that the average values of the variable in remote areas becomes equal to Scotland's average.

other. However, the direct effect, obtained from the AHEI regression was positive. The computation of the first order approximation of the effect of an increase of 1 year in average age is an increase in the remoteness premium of 0.125 points per year of aging in remote small towns and 0.150 in remote rural areas.

The link between demographics and food prices may have implications for the welfare of a population that is getting older. The “remoteness premium” paid by Scotland’s consumers living in remote rural areas is expected to increase over time. In fact, according to the National Records of Scotland, the country is facing a demographic time bomb in the coming decades with a sharp rise in the older population, prompting fears over how hard-pressed services will cope. The number of pensioners is expected to soar by 28 percent in just 25 years (NRS 2017). The estimated model predicts that aging consumers will spend more to buy their food. Consequently, higher prices coped with less mobility for shopping may bring lower welfare levels.

As regards scenario B, access to discount stores in remote areas is expected to reduce the remoteness premium. This result is consistent with Dawson et al. (2008), who stressed the importance of store formats for food affordability in remote areas. The simulation in Table 8 considers the effects of a policy that can increase the share of households with access to discount stores from 0.93 in remote small towns and 0.89 in remote rural areas to 0.96 (Scotland’s average). The impact of such policy is a reduction of the remoteness premium by 0.19 in remote small towns and 0.44 in remote rural areas. Note that these outcomes are driven by the small number of households in the panel that did not access discount stores.

Combining the results from the AHEI estimation in [Table 5](#) and the computations in [Tables 7](#) and [8](#), it is possible to conclude that this trend would be very important for a relatively limited number of citizens. New openings of discount stores available for households with no prior access is expected to reduce the expensiveness of the household's basket by 6 points. However, this large benefit is captured only by 7 percent of population in remote rural areas and 3 percent in remote small towns. In addition, it must be noted that the estimation ignores the possible impact of opening of discount stores in remote areas (or other incentives to access) on the place effect; for instance, a new discount store might lead to a significant price reduction in the area due to competition.

As regards scenario C, the econometric model concluded that social deprivation has some effect on food expensiveness. To simulate this scenario, it was assumed that a change in the distribution of households in remote areas by the SIMD 2016 indicator to mimic Scotland's average (e.g., due to an improvement in services or to local development). However, the effect of this policy on food expensiveness is limited. The area premium is expected to decrease by 0.14 points in remote rural areas and to increase by 0.08 points in remote small towns. The result was driven by the relatively small share of households falling in the fifth quintile of SIMD 2016 in remote areas (0.09 in remote small towns and 0.03 in remote rural areas). Therefore, the policy actually led to an increase in the number of households in the fifth quintile, which is the one with the strongest effect on price (see [Table 5](#)). The net effect of two opposite forces (i.e., increase in the fifth quintile, decrease in third and fourth) was a limited impact on the area premium.

Conclusion

The motivation of this paper has been to test whether the results from previous studies finding that remote areas are affected by higher prices than the average in Scotland hold when actual household purchases are considered. This was analyzed by constructing a recently introduced price index (AHEI) that takes into consideration the actual basket purchased by each household.

The research did not find an economically significant "remoteness premium" paid by people living in those areas of Scotland. Compared to an average Scotland household, those living in remote small towns and remote rural areas are found to have a small higher value of the AHEI (0.3 and 0.4 percent, respectively). The estimate is much smaller than the estimates in the literature about rural Scotland based on store prices (10–40 percent). Correcting the estimate of the remoteness premium to consider actual purchasing prices instead of prices at local stores is the main contribution of the paper.

Once actual purchases are considered and quality differences are accounted for, the estimated magnitude of the remoteness premium decreases. The same baskets that are purchased by household living in remote areas would have been marginally less expensive if bought by other Scottish households. This result may imply that even if local store prices are higher than elsewhere (as detected by previous studies), households in remote areas are able to purchase food from less expensive sources (shopping outside local areas). Any perception of low purchasing power might be due to lower incomes and high local-store prices than food expensiveness (i.e., what households pay for food actually). This is something that deserves further research particularly on the reasons behind those perceptions.

In addition, the research also explored the effect of several variables on the AHEI. On average, and keeping all other factors constant, shopping strategy, and its constraints were found to affect the AHEI value so did household's demographic characteristics. On average, women pay less than men for the same food basket. The AHEI on average decreases with the number of children in the household. Marital status was not found statistically significant. Households with income lower than £30,000 on average pay less than others for the same food basket (after controlling for social deprivation). The relationship between the AHEI and age was non-linear and Main Shoppers around 32 years old pay the lowest prices, and younger and older people pay more for their food basket.

Characteristics of the areas also had influence on food expensiveness. On average, access to discounters was expected to lower the AHEI; households located in highly deprived areas were associated with higher values of the AHEI. However, store formats and social deprivation are not the only characteristics of local areas affecting food expensiveness in remote areas. The model found that a residual place effect accounted for a large share of the remoteness premium. The identification of the factors determining such place effect is a topic for future research.

The regression model tested whether living in remote areas may have indirect effects on the AHEI through the consumers' shopping strategy or not. To estimate these effects, each shopping strategy variable (the average number of weekly trips for grocery shopping in the year, the number of different retail chains that the consumer visited in the year, and a concentration index of expenditure by household among different retail chains) was regressed on each other and a vector of household and local areas characteristics. The number of shopping trips and the number of visited stores exhibited a positive association with each other and a negative association with expenditure concentration. However, the regression model found evidence only of a place effect on shopping strategy in remote rural areas.

Households shopping more frequently are expected to visit more stores and to distribute their food expenditure more than others. Similarly, households preferring to concentrate their food expenditures in few outlets are expected to visit less stores and to shop less frequently than others. Household characteristics affected the three shopping-strategy variables differently. Main-Shopper age had a statistically significant effect on shopping frequency only. Female shoppers on average visited more shops and concentrated their expenditure more than men. Married consumers with children on average visited a lower number of stores but split their expenditure more evenly across stores than others. Households with low income (less than £30,000) on average shopped more frequently and visited more stores than others but they concentrate their expenditure more. The regressions supported the conclusion that area characteristics affected shopping strategy. However, the effect was captured by the area dummies, while access to discount stores was not statistically significant. Deprivation affected shopping frequency only.

The estimations were used to simulate three scenarios related to changes in population's age, access to discount store, and reducing deprivation. The results show that aging of population in remote areas may bring an increase in the remoteness premium whilst increasing access to discount stores would reduce it; however, the effect on food expensiveness of reducing the deprivation would be limited.

The conclusions of the paper were limited by data unavailability. First, our dataset was representative at Scotland level only. This limitation prevented analyses at the local area level and the use of hierarchical models. Second, with existing data sources, only one between price distribution at local level and actual purchases can be observed at the time. Datasets reporting store prices do not consider household purchases and dataset collecting household data do not report prices in the area. Future research may consider combining the two approaches to observe how households in remote areas react to changes in local prices and the drivers of outshopping.

The use of household data instead of store prices to compute the remoteness premium is a promising approach that can be applied to several topics for future research. The effects of large exogenous shocks (such as the CoViD-19 pandemics or Brexit) on population in remote areas can be estimated with this approach.

ENDNOTES

¹ The SIMD is an index used by government bodies in Scotland to support policy and decision making, which measures deprivation across seven domains: current income, employment, health, education, skills and training, housing, geographic access, and crime. These seven domains are calculated and weighted for 6,976 small areas, called “data zones,” with roughly equal population.

² The Scottish Government rural/urban classification (Scottish Government, 2018) consists of “Large Urban Areas” (settlements of 125,000 people and over), “Other Urban Areas” (settlements of 10,000 to 124,999 people). “Accessible Small Towns” (settlements of 3,000 to 9,999 people, and within a 30-minute drive time of a Settlement of 10,000 or more), “Remote Small Towns” (settlements of 3,000 to 9,999 people, and with a drive time of over 30 minutes to a settlement of 10,000 or more), “Accessible Rural Areas” (areas with a population of less than 3,000 people, and within a 30-minute drive time of a Settlement of 10,000 or more), “Remote Rural Areas” (areas with a population of less than 3,000 people, and with a drive time of over 30 minutes to a Settlement of 10,000 or more).

³ Discount stores include the following stores: Asda, Discounters (Aldi, Lidl), Iceland, Total Bargain stores, Other freezer centers, Symbol/independent. Supermarkets include the following stores: Tesco, Morrisons, The Cooperative, Sainsbury’s, and Other supermarkets. Premium chains such as Marks & Spencer or Waitrose were not included in the graph.

⁴ In the Kantar Worldpanel dataset, this is the person doing the purchases.

⁵ Measured by a Herfindahl index (Martin, 2002).

⁶ The per capita food expenditure is computed by dividing household food expenditure reported in the Kantar Worldpanel by the number of household members.

⁷ A Chow test failed to reject the null hypothesis of no structural break between 2017 and 2018, supporting the choice of pooling the data.

⁸ Computation of Variance Inflation Factors excluded severe multicollinearity problems.

⁹ This result contrasts with Aguiar and Hurst (2007), where the middle-age household pays the highest prices due to time constraints to search for lower prices. The difference can be explained by two

factors: the difference age span in the two samples and the fact that the model controls for shopping habits. Aguiar and Hurst considered Main Shoppers from 25 to 75 years of age, while the age in this sample ranged from 18 to 89. The high values of AHEI of over 80 years old households influence the result.

¹⁰ An F -test on the joint significance of the coefficients of variables S2 to S5 rejected the null hypothesis with a p -value less than 0.001.

¹¹ By properties of ordinary least square estimators, the contributions add up to the area premium.

¹² The system used the following additional instruments: dummy variables identifying households using car as transportation mean for shopping, owning a freezer, not having access to the internet and having access to stores of large supermarket chains.

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