Modelling the customer potential of retail food stores: A case study from the Turiec region in Slovakia, 2020

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The study uses a modified version of the Huff model to estimate the distribution of customer potential in the existing network of retail food stores in the municipalities of the Turiec region. The model takes into account the attractiveness of stores expressed by their area, their affinity based on inter-municipal commuting, and the accessibility of stores over time from all municipalities in the region.

Affinity is not included in the original version of the Huff model, and it represents an innovative element of the study. It captures the tendency of local residents to visit other municipalities more often. Affinity values are derived from daily commuting data. It assumes that people shop most often at their place of residence or work. The more people live in a municipality and commute there daily to work or school, the greater the number of potential customers in stores in that municipality.

Thus, including affinity in the model allows a more accurate estimate of the probability of shopping, such that the probability of shopping increases (decreases) with higher (lower) affinity. The resulting values of the probability of shopping and the magnitude of the customer potential are specified for the largest chains on the Slovak market (Billa, Coop Jednota, Kaufland, Lidl, and Tesco). In addition to the absolute values, the results are projected onto 100 m^2 of stores belonging to each chain or located in specific municipalities, using the intensity indicator of the customer potential.

The authors find that the retail chains Tesco and Coop Jednota have the highest purchase

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probability values. Of the retail stores, residents of the region prefer the stores in Martin, followed by Turčianske Teplice. The model indicates some imbalance in the distribution of customer potential among the largest food retailers. While Tesco stores and Coop Jednota serve one-third and one-quarter of the customer potential, respectively, Kaufland, Billa, and Lidl are only attractive for approximately one in ten customers each.

Each retail chain has a slightly disproportionate share in terms of model customers and sales area: while Tesco's share of customers is higher than its share of total sales area, the opposite is true for Coop Jednota. The Coop Jednota chain has the largest store network in the region, which means that its stores are the least intensively used by shoppers in terms of sales area: the number of customers per 100 m^2 of sales area is only around two thirds of the figure for the other large chains. The intensity of customer potential shows an underutilised sales area for Coop Jednota. The high values of this indicator in the remaining four chains can be interpreted as a possible insufficient satisfaction of the customer potential by the sales area. The authors have also identified a specific category of settlements without a food store in the region, which could be called a „rural food desert".

The model is widely applicable and may be a good tool for conceptualising sales development strategies in the fight for the customer.

Keywords:
Huff model,
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intensity of customer potential,
probability of purchase,
affinity

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Introduction

Nowadays, retailing and consumption can be considered as sets of social actions that are intimately tied, extending beyond self-evident relationships, as argued by Nagy et al. (2016). Therefore, the consideration of consumption, or in other words, the customer potential, is essential for any investigation of retail networks. This is the population that represents the potential customer base.

Using a modified Huff model, we aim to model the distribution of the customer potential of the Turiec region in Slovakia among specific retail services operating in the sale of food and associated goods segment. In our study, we apply a modified version of a Huff model to express, with the highest accuracy possible, the distribution of the customer potential of an existing network of retail food stores in the municipalities of the Turiec region. The resulting values are specified, particularly for the largest retail food chains operating in the Slovak market.

A new element in our modified version of the Huff model is affinity, which accounts not only for the population of the municipality where the retail store is located but also for the population who tends to visit the municipality daily, mostly for work-related or educational purposes. Affinity allows us to estimate the patterns of the daily activity of the population and refine the probability of purchase in particular retail stores. Thus, affinity increases the probability of purchases in natural centres with higher daily commuter inflows and simultaneously decreases the probability of purchase in peripheral areas.

The processes, flows, and interactions between localities are not concentrated in points of space, but they 'travel' in it (Rusnák–Korec 2018, p. 83). The intensity or volume of possible interactions between social or economic groups or other entities located in different locations can be analysed using potential models (e.g., Kincses–Tóth 2012, Tóth–Kincses 2015, Benedek et al. 2018). These have been conceptually, empirically, and historically associated with the gravity model, suggesting that two territorially separated groups of people generate a mutual interaction in proportion to the product of the sizes of the groups, and that this interaction is impeded by the frictional effect of the intervening distance between these two groups (e.g. Rich 1980, Tóth et al. 2013, Tóth–Kincses 2015, Szabó–Sipos 2020, etc.). In other words, the size (real or potential) of the interaction between two points (localities, settlements) on the surface of the earth is thus larger, that is, the greater their population (mass), the smaller the distance between these localities (spatially, temporally, etc.). Based on the type of mass, the terms 'interaction', 'economic', or 'contact' potentials can be used alternatively (see Rich 1980, p. 12, Westaway in Rich 1980, p. 12). This potential interaction may be of goods, telephone calls, migration volumes, and a whole range of other social and economic contacts, such as journeys to work, shops, schools, or entertainment (Rich 1980). Thus, interaction models describe the movement (flows) of persons, materials, information, or other entities between territorial units (Paulov 1993).

The basic idea of a model of interaction potential presented above is also used in the Huff probability model. It is among the frequently used models in retail geography, for example, for determining the catchment area of retail operations or shopping centres. The Huff model provides a sound conceptual and operational basis for understanding and determining the retail trade area of a shopping centre (Huff 1963).

In our model, under interactions, we can imagine consumers from a municipality *i* who shop in a store *j*. Therefore, the larger municipality *i* is (the source of potential customers) and the shorter the time required to move between municipality *i* and municipality *j* wherein the store is located, the greater the size of this interaction. The interactions themselves are also influenced by certain circumstances that we can refer to as the attractiveness of the store.

The attractiveness of retail outlets can be quantified based on many factors. Orpana–Lampinen (2003) emphasise that different attractiveness factors are crucial for various types of stores. The most commonly used and easiest quantifiable factor is the size of the store given by the number of employees (e.g., Jankuné Kürthy et al. 2012), but especially by the size of the sales area (e.g. Guy 1998, Teller–Reutterer 2008, etc.). The sales area is primarily used to evaluate the attractiveness of large retail operations (Ordeltová–Szczyrba 2006, Spilková 2010, Kunc et al. 2012a, Trembošová–Dubcová 2013, Križan et al. 2015, Mitríkova et al. 2015, Kunc et al. 2016 and many others). Reigadinha et al. (2017) also use its size as the main indicator of attractiveness in their research on the location of food chain stores in Portugal.

The attractiveness of sales units is also influenced by other factors: pricing, opening hours, visibility of articles for sale, advertising campaigns, speed of service, willingness of personnel, variety of products being sold, share of goods from domestic sources, as well as benefits for regular customers, such as loyalty programs or club cards, the number of parking spaces at the store, and accompanying social events (e.g. Guy 1998, Teller–Reutterer 2008, Križan et al. 2015, etc.).

In addition to these direct factors, based on the existence of the store itself and its traits, the attractiveness of a store is also influenced by several external factors, such as the type of store location within a settlement (Guy 1998, Kunc et al. 2012a, 2016), the agglomeration effect or location of the store within a retail cluster (Li–Liu 2012, De Beule et al. 2014, 2015, Yoon 2018), and the degree of diversity of the retail agglomeration (Yoon 2018, Reigadinha et al. 2017).

All of these circumstances and factors create a type of framework wherein the shopping behaviour of the population is shaped. Meanwhile, satisfying the needs of consumers at the highest possible level in both quality and quantity has become a priority (Sikos T. 2019). In the case of purchasing food and consumer goods, we discuss convenience shopping, which typically occurs in hypermarkets, supermarkets, and other grocery stores (e.g. Guy 1998, Spilková 2012, Kunc et al.

2013, etc.). Minimal mobility is preferred when making these purchases (Kunc et al. 2013). Thus, they take place predominately at or near the place of residence, depending on their shopping facilities and the size of the municipality. Convenience shopping is also made at the place of employment (Mitríková 2008); therefore, shopping behaviour is also influenced by commuting for work and school. Kunc et al. (2013), for example, confirm this in their research on the hinterlands of Brno in 2010. They state that 56% of the inhabitants of the surrounding municipalities who travel daily to Brno for work also make basic food purchases in Brno.

As previously mentioned, the size of the examined interactions is closely associated with the accessibility of the store. Michniak (2013) introduces various methods of appraising the accessibility of retail stores, and Ordeltová–Szczyrba (2006) and Kunc et al. (2012a, 2012b), for example, also report about the accessibility of stores by public and individual transport. Accessibility, as measured by distance, is the easiest to quantify. Szczyrba (2002) and Ordeltová–Szczyrba (2006), for example, work with physical distance, but in retail, time accessibility is used more often (e.g., Jones–Simmons 1990, 1993, Dennis et al. 2002, Kunc et al. 2012a, 2012b, Bilková–Križan 2015). Križan deals with more complex measures of retail accessibility in his works (Križan 2007, Križan et al. 2008).

In retail geography, the Huff model is often used in its basic form, where the attractiveness of the store is given by one indicator, most often the sales area (e.g., Trembošová 2009, Mitríková et al. 2015). In his study, Huff (1963) assumes that consumers select a shopping centre based on its attractiveness, which depends on the size of the store and the distance between the consumer's place of residence and the point of purchase itself.

In recent years, an increasing number of studies have adopted a modified version of the original Huff model. Huff himself, in 2003, used a supplemented version of his original model to estimate revenues. Merino–Ramirez-Nafarrate (2016) later apply his model in a modified version to estimate the monthly sales of retail chains in Mexico. Gripsrud–Benito (2005) use a logarithmic transformation of the Huff model to study the international expansion of selected British retail chains, and Li–Liu (2012) estimate the potential sales of Wal-Mart and Kmart in the Greater Cincinnati Area, Ohio. The authors express the attractiveness of the stores using a combination of the size of the store and the agglomeration effect (the number of other stores within the walking distance of the store being surveyed).

Yoon's study (2018) examines the relationships between retail clusters in Seoul, Korea, using a modified version of the Huff model. It expresses attractiveness using a combination of the number of sales units, their degree of diversity, and the share of recreational or leisure services located in the cluster. Dolega et al. (2016) add the share of anchor stores to the same attractiveness indicators, subtract empty retail space, and identify the catchment areas of urban trade centres in the United Kingdom.

Study region

We choose the Turiec region for the application of the Huff model. It comprises 69 municipalities with a total population of approximately 112,000 inhabitants (Figure A1 in Appendix). The population is concentrated predominately in the Turiec Basin, and its population density is approximately 300 inhabitants/km^2. The basin has an elongated north–south shape and extends at an elevation ranging from approximately 400 to 600 m above sea level (Figure A2 in Appendix). This is an intensively used agricultural land with a high density of settlements and industrial centres in Martin, Vrútky, and Turčianske Teplice (Miklós–Izakovičová 2006). The basin is lined on all sides by mountains. These represent a travel barrier, thanks to which Turiec is characterised by a high degree of closure. According to Bezák (2014), this region (excluding the territory of the municipality of Turček) is internally coherent and externally closed with regard to daily movement for work, making it one of the most closed areas in Slovakia. In terms of settlement structure, the region has four towns (Martin, Vrútky, Turany, Turčianske Teplice) that are home to 64.4% of the region's population. The largest town (48.1% of the region's population) is the district town of Martin (Table 1). Presently, it is functionally connected with Vrútky, which forms a single urban unit with a population of more than 60,000. The third largest town, Turčianske Teplice (approximately 6,200 inhabitants), lies in the southern part of the region and significantly lags behind the Martin-Vrútky conglomerate in size. The municipality of Sučany (4,722 inhabitants) also ranks among the larger settlements. The region is abundantly represented in terms of small municipalities with up to 500 inhabitants (37). The settlements in the region are interconnected by a road network that has a density of 3.05 km/1000 inhabitants (SSC 2020). All the four towns in the region are also linked by rail. Overall, there are 121 stores for food and associated goods in the region, and 50 municipalities offer the opportunity to buy groceries directly. However, two-thirds of these have only one store, usually the Coop Jednota brand.

Table 1

Settlement structure of the Turiec region in Slovakia, 2020

Size category of the settlements (population)	Number of municipalities	Population	Share of population, %	Cumulative share of population, %
up to 200	19	2,423	2.2	2.2
200–499	18	5,739	5.1	7.3
500–999	14	9,870	8.8	16.1
1,000–1,999	13	16,999	15.2	31.3
2,000–4,999	2	8,975	8.0	39.4
5,000–9,999*	2	14,006	12.5	51.9
50,000–199,999	1	53,763	48.1	100.0
Total	69	111,775	100.0	x

Note: * The size categories of settlements 10,000–19,999 and 20,000–49,999 are not represented in the region.
Source: [1], authors' calculations.

Calculation methods and database preparation

The Huff model assumes that each consumer selects from a set of shopping sites according to the level of personal usefulness. This is directly proportional to the attractiveness of the store and indirectly proportional to the distance between the point of purchase and the consumer. In our study, we identify the shopping sites with the centroids of the municipalities where the grocery stores are located.

We add a new element, the affinity a_{ij}, to the original Huff model. With this, we express the inclination of the residents of municipalities to visit other municipalities more often.

We can then write the modified form of the model mathematically as follows:

$$P_{ij} = \frac{w_j \cdot a_{ij} \cdot f_{ij}}{\sum_{j=1}^{121} w_j \cdot a_{ij} \cdot f_{ij}} \quad (1)$$

where w_j is the attractiveness of store j expressed by the size of its area, a_{ij} is the affinity of municipality i with respect to the municipality in which store j is located, f_{ij} is the level of impedance, that is, the resistance of the environment with respect to the need to overcome the distance between municipality i and the municipality in which store j is located.

The result of the calculation according to Equation (1) is an estimate of the probability P_{ij} that an inhabitant of municipality i will shop in store j. The sum of the probabilities of purchase for all stores j located in a specific municipality gives us the magnitude of the probability that a resident of municipality i will travel to this specific municipality to shop.

Attractiveness of the store

We identify the attractiveness w_j of store j in our model based on the size of the built-up area occupied by the store building. This includes the size of the store's area itself along with storage spaces, spaces for employees, or a special area for shopping carts. We start with the assumption that the larger the store area, the more attractive the store is for potential customers.

We generate data on the size of stores from a map layer of buildings from the source OpenStreetMap ([3]). To identify the exact retail stores in the food and related goods segment, we use the attribute table associated with the map layer of buildings. More specifically, we work with the attribute 'type', which specifies the use of the building, and the attribute 'name', which includes the brand name. Subsequently, we verify the existence of retail stores through Google Maps ([4]) using the grocery store identification functionality. We work especially with the five most important retail chains operating in Slovakia: Billa, Coop Jednota, Kaufland, Lidl, and Tesco. These five selected chains have been reported to generate a sales volume of € 6.01 billion in 2019, which represents 66% of sales in the food and related goods segment ([5]). We also include less significant brands, such as CBA, Fresh, and Agro-Milk, in the sixth aggregated category 'Other stores'. The representation of retail chains in the region's municipalities and the spatial distribution of their stores are presented in Figure A3 in Appendix and Table 2.

For municipalities without grocery stores (19), the value of w_j is zero. These are predominately small rural municipalities, wherein these stores are typically absent (Nagy et al. 2016).

Affinity

Affinity a_{ij} is a new element that we add to the original Huff model. In geometry, affinity is defined as the relationship between two spatial units (Piaček–Kravčík 1999). In our study, we understand affinity as a property of shoppers regularly located in certain municipalities. We derive the evaluation of the affinity a_{ij} of municipality i with respect to the municipality wherein store j is located from the size of the commuter flow of residents from municipality i to the municipality with store j because grocery purchases are often made at the place of employment (Mitríková 2008). Put simply, affinity a_{ij} is an expression of the 'attractiveness' of the municipality with store j for the residents of municipality i. The more the inhabitants who commute to the municipality with store j, the greater the number of potential customers of store j. Because the mutual commuter flows between municipalities differ, $a_{ij} \neq a_{ji}$ is valid. Mathematically, we calculate affinity a_{ij} according to the following equation:

$$a_{ij} = \frac{D_{ij}}{\sum_{i=1}^{69} D_{ij}} + 1 \qquad (2)$$

where D_{ij} is the number of residents of municipality i who commute to work in the municipality with store j, $\sum_{i=1}^{69} D_{ij}$ represents the total number of persons commuting to the municipality with store j from all other municipalities in the region.

If there is a non-zero commuter flow between municipality i and the municipality with store j, the values of affinity calculated according to Equation (2) range in the interval (1,2›, while the extreme value $a_{ij} = 2$ implies that commuter flow from only one municipality i goes to the municipality with store j.

If there is no commuter flow between municipality i and the municipality with store j, we explicitly set affinity aij according to the distance between the two municipalities and choose a time of 25 min as the limit value. We consider this time to be the upper limit of residents' willingness to travel to another municipality to buy food. For pairs of municipalities whose time distance exceed 25 min, we set the affinity value to 0. Thus, we eliminate the extremely unlikely purchasing interactions between peripheral municipalities in the region. Jones–Simmons (1990, 1993) and Dennis et al. (2002) also apply a similar maximum time limit to travel for regular shopping in their work.

For pairs of municipalities with no commuter flow and a mutual time distance of up to 25 min, we use an affinity of a_{ij}=1 in the model. This step reflects the existence of a (low, but not zero) probability of the purchase of inhabitants of municipality *i* in store *j* following from the mutual proximity of municipality *i* and the municipality in which store *j* is located. In such cases, P_{ij} depends only on the attractiveness of the store and the impedance.

A special case is the affinity a_{ii} of a municipality with respect to itself. This relates to the population of the municipality in which a store is located. For these cases, we determine the affinity to be the share of economically active residents from municipality *i* working in the place of residence out of all economically active employed inhabitants of municipality *i*. We increase this share by +1 when determining the affinity, analogous to Equation (2). Thus, if the affinity of a municipality with respect to itself is achieved, for example, the value a_{ii} = 1.65, then in the given municipality, out of all its economically active employed inhabitants, 65% work in their place of residence and 35% go to another municipality for work. Residents living and working in the same municipality are most likely to buy food at their place of residence. Therefore, the affinity so determined tries to affect the potential of customers from the municipality in which store *j* is located (its so-called 'own' customer potential).

Impedance

We can define impedance simply as an expression of the population's willingness to cover a distance for a certain purpose. In our study, impedance f_{ij} is expressed as a function quantifying the willingness of inhabitants from municipality *i* to travel to store *j* for shopping. The mathematical notation of the function used in our model is as follows:

$$f_{ij} = 2.0469 \cdot x^{-1.331} \quad (3)$$

where *x* is the travel time distance from municipality *i* to a municipality with store *j* (min).

Therefore, the value of the decreasing power function (Figure 1), in which the travel time in minutes appears as an independent variable *x*, enters our model. Thus, the greater the travel time *x*, the smaller the value of the dependent variable f_{ij}, and the lower the probability of a purchase.

To illustrate the properties of the road network, Figure A4 in Appendix shows the accessibility of the five largest settlements (over 4,500 inhabitants) from other municipalities in the region.

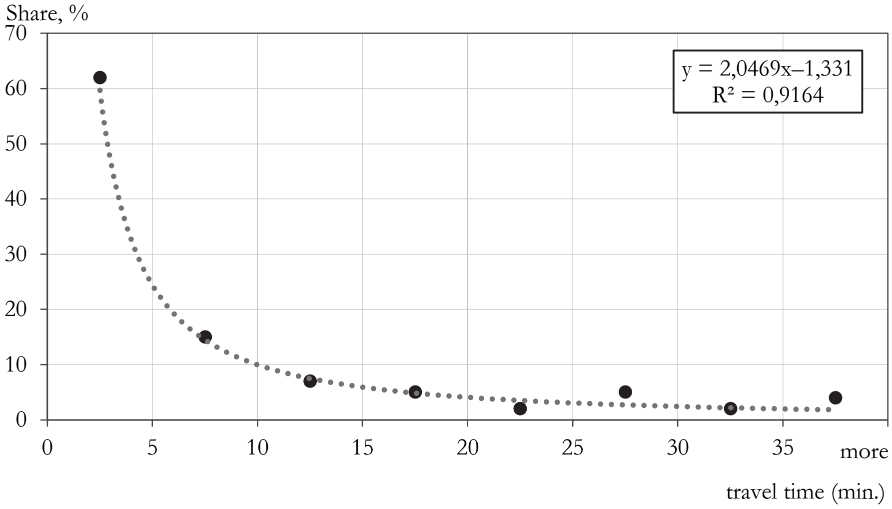
The travel time (in min) needed to move from each municipality to each municipality is measured in this road network, and the reference points of the measurements are the centroids of the built-up parts of individual municipalities. When measuring the time distance from one municipality to another on a real road network, we consider speed limits, intersections with the necessity to yield, regularly occurring congestion, and limitations in speed due to land relief (bends, significant ascents, or descents), according to Stanek et al. (2021).

For the inhabitants of municipalities in which at least one grocery store is located (50 municipalities), the travel time required to go to the store 'within the municipality' is uniformly set at $x = 3$ min. This value corresponds to the average length of real movements within the areas of such municipalities.

To determine the most suitable form of the impedance function f_{ij} itself, we gradually assign the shares of the economically active population of the whole region commuting for work according to the time spent travelling to work based on five-minute intervals. We derive the necessary data from the Slovak Republic Statistical Office database ([6]). In all, 62% of the population needs up to 5 min to get to work, 14% from 5 to 10 min, 7% from 10 to 15 min, etc. We label the points representing the mentioned dependence (the proportion commuting from the time) on a Figure 1, in which we subsequently render several types of functions describing their distribution in the field of the graph. The power function (3) with a coefficient of determination $R^2 = 92\%$, which we subsequently use in the model, proves to be the most suitable function.

Figure 1

Share of commuters for work into the Turiec region by travel time in Slovakia, 2011



Source: [3, 6], Stanek et al. (2021), authors' calculations.

Number of model customers

In the next step, we put the probability P_{ij} calculated according to Equation (1) into a general starting-bounded interaction model (4), wherefrom we obtain the resulting number of probable interactions T_{ij} (i.e. the number of model customers) heading from municipality i to store j to purchase food. The mathematical notation for this process is presented as follows.

$$T_{ij} = O_i \cdot P_{ij} \tag{4}$$

where O_i is the population of municipality i, P_{ij} is the purchasing probability of residents from municipality i in store j, calculated according to Equation (1).

The number of inhabitants of a region's municipalities (O_i) used in the calculations is taken from the database of the Statistical Office of the Slovak Republic as of 31 December 2019 ([1]). The spatial distribution of the population in the municipalities of this region is shown in Figure A3 in Appendix.

We obtain the probability of purchase of the residents of municipality i in the stores of a specific retail chain by the sum of the probabilities of purchase of the inhabitants of municipality i for all stores j in the region that belongs to the given chain (Figure A5 in Appendix).

The result of the calculations of T_{ij} for all pairs i and j is a matrix of size 69 × 121, the rows of which are data for all municipalities i of the region (i = 69), and the columns of which are data for all the stores j in the region (j = 121). The elements of the matrix are the number of model customers (customer potential) from municipalities i purchasing in stores j, and the sum of each row is equal to the number of inhabitants of the given municipality i. Then, the data in the columns determine how many model customers from the region's municipalities shop in store j. We recall that with the term 'model customers' or 'customer potential' we do not mean people who make a purchase directly, but the entire group of people who are served by purchases from store j.

We obtain the size of the customer potential of a specific chain by adding up the model number of customers for all its stores j in the region.

Summary evaluation

For a summary assessment of the examined retail chains and their mutual comparison, we use the indicator intensity of consumer potential, the value of which determines the number of model customers per 100 m^2 of stores in a given retail chain. When calculating this indicator, we divide the total number of model customers shopping in stores j of the relevant retail chain by the total area of all of its stores.

We also express this statistic locally for individual municipalities: we recalculate the number of model customers from the region to 100 m^2 of stores j located in individual municipalities of the region.

We perform data preparation, calculations, and visualisations in the environment of the programs, Arc Gis 10.4 and Microsoft Excel 365.

Empirical analysis and findings

Probability of purchase

The probability of the inhabitants of the municipalities in the Turiec region shopping in the stores of individual chains is shown in Figure A5 in Appendix. In all the monitored retail chains, it is confirmed that the highest probability of purchasing occurs mainly in the municipalities wherein their stores are located. This is mainly because customers shop at their place of residence (the so-called own potential). This is clearly visible in the case of the Billa, Lidl, and Kaufland retail chains.

The Billa retail chain, with stores located only in the two district towns, achieves a higher probability in Turčianske Teplice than in Martin. This is because of the higher measure of competition in Martin (stores of all five retail chains) compared with Turčianske Teplice (stores of three of the five retail chains).

The Kaufland and Lidl retail chains show a similar spatial pattern in the distribution of the probability of purchase. They achieve the largest values in Martin because their stores are only located there or in their wider surroundings. Conversely, we see the lowest values in the southern part of the region, where the attractiveness of more distant stores is logically reduced by the competition effect (Li–Liu 2012) of the Billa, Coop Jednota, and Tesco stores in Turčianske Teplice.

Compared with the others, the Coop Jednota retail chain has the highest probability of purchase in most municipalities. It draws from the densest network of stores in the region (stores in 45 municipalities), which largely emerge from the period of socialism (Mitríková 2008). We record higher values in the southern part of the region because there is less competition there.

The Tesco retail chain also has a high probability of purchase, although compared with Coop Jednota, it has significantly fewer stores, and customers can visit only three municipalities. The ability of the Tesco brand to compete with Coop Jednota follows from the comparable sales area and the fact that its stores are located in both district cities. These are the natural catchment areas for commuters in the region, and they gather customer potential based on their accessibility and size. The wider offer of other (non-food) goods in Tesco stores also probably contributes to a certain measure.

In the category of other food retailers, we can see two clusters of increased purchase probability values. The first is located in the central part of the region, which is relatively distant from both the main centres. The second aggregation is formed in the northeast of the region. Both result from the offer of services of stores of less important brands (CBA, Fresh, etc.), whose only competitors in this area are Coop Jednota stores. We can also note a certain paradox in the case of the city of Martin. Although the number of stores of other sellers is significant, the probability of Martin residents buying in them is relatively low. This is associated with the elementary logic of the spatial structure of the retail network, which is characterised by a higher degree of concentration compared with the concentration of the population (Hagget in Szczyrba 2006, in Mitríková 2008, and others). The probability of shopping in the other stores category in Martin is also reduced by the higher competition effect (Li–Liu 2012) associated with the stores of large retail chains. We explain the low values of the probability of purchase in stores of other brands in the municipalities of the southeastern part of the region by their weak representation in this area combined with the dominance of the Coop Jednota, Tesco, and Billa retail chains.

By summing up the probabilities of a purchase of the inhabitants of municipality *i* for all stores *j* located in a specific municipality, we estimate the probability that an inhabitant of municipality *i* will travel to this municipality for shopping. In Figure A6 in Appendix, we depict the values of the probability of purchase in selected (the largest) municipalities in the region. In nearly all the municipalities in the region, their residents are most likely to choose to shop in Martin. Only Turčianske Teplice and the municipalities in its immediate vicinity have a comparable probability of purchasing at another shopping place.

Distribution of customer potential in the region

The distribution of the customer potential of the region between retail chains and municipalities and the share of retail chains in terms of sales area are shown in Table 2 and Figures 2 and A7 in Appendix.

One-third of the customer potential (35,864) is served by Tesco stores, while one-quarter (27,386) is served by Coop Jednota. The high share of Tesco customers is associated with the large sales area of its operations (more than a quarter of the share), which are placed relatively efficiently in the largest settlements. This retail chain gained a time advantage in the choice of location over the competition with its activity at the beginning of the millennium, when a boom in large-scale food stores occurred in Slovakia (Mitríková 2008, Križan 2009). In the case of Coop Jednota, the dominant share of the sales area (34%) is significantly higher than the share of customer potential (24%). This discrepancy is caused by the deconcentrated distribution of stores in the region, primarily in rural environments with reduced demand (e.g. Szczyrba 2006, Paddison–Calderwood 2007, Bilková et al. 2017, 2018, etc.). Every tenth customer buys in a Kaufland store, as well as in the stores of the Billa chain. The lowest share of customers (8%) belongs to the Lidl brand. In all three, the share of customer potential is slightly higher than their share in the total sales area. The remaining 15% of shoppers are divided among other sellers, which roughly corresponds to their share in the total area of stores in the region.

Table 2

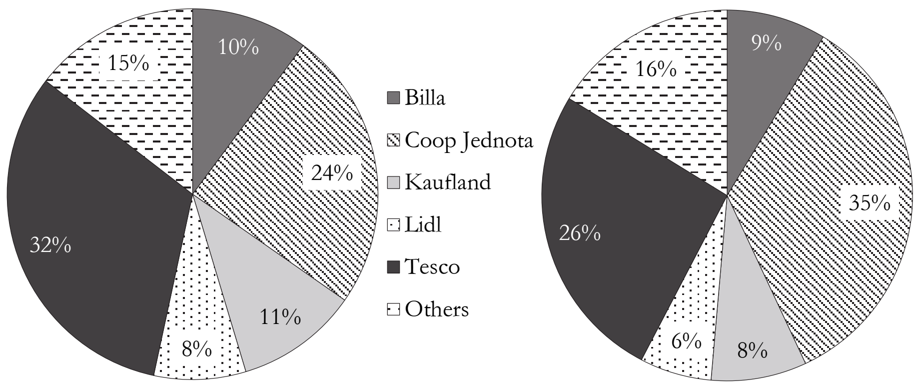
Customer potential of selected retail chains in the Turiec region in Slovakia, 2020

Retail chain	Number of stores	Number of municipalities with a store	Sales area, m²	Number of model customers	Intensity of consumer potential, customers per 100 m²
Billa	4	2	4,752	11,383	240
Coop Jednota	64	45	18,857	27,386	145
Kaufland	1	1	4,575	11,927	268
Lidl	2	1	3,435	8,954	268
Tesco	5	3	14,317	35,864	251
Other stores	45	23	8,904	16,261	183
For the region	121	50	54,840	111,775	204

Source: [1, 3, 6], Stanek et al. (2021), authors' calculations.

Figure 2

Distribution of the customer potential (on the left) and the area of food stores (on the right) of the Turiec region among selected retail chains in Slovakia



Source: [3, 6], Stanek et al. (2021), authors' calculations.

Martin (Figure A7 in Appendix), which serves approximately 90,000 model customers (79% of the entire region), clearly emerges as the largest purchasing site. The attractiveness of food stores for potential customers is increased by the total agglomeration effect of retail (Li–Liu 2012, De Beule et al. 2015), which is most pronounced in the studied region in Martin. Reigadinha et al. (2017) describe a similar phenomenon in their research on the location of food stores in selected retail chains in the Oporto District of the city of Oporto, Portugal. Most model customers in Martin shop in Tesco stores (approximately 40%), while the share of other retail chains ranges from 10% to 14%. Turčianske Teplice, where Coop

Jednota has a dominant share, draws the second largest number of model customers, approximately 7,800 (7%). Tesco and Billa account for one-quarter of the customer potential in this town. The municipalities of Turany and Sučany both reach approximately 2,000 model customers (4% of the region), and more than 40% of them are those of smaller chains (mainly CBA). Coop Jednota, together with the Tesco chain, also has a significant representation in Sučany. Vrútky serves only 1,100 model customers (1%), 92% of whom shop at Coop Jednota stores. The low share of customers is caused by the presence of large sales capacities in neighbouring Martin. Stores of foreign chains in Vrútky are absent. Coop Jednota, either alone or in combination with the store of another, less important chain, dominates in the region's smaller municipalities. The municipalities of Blatnica, Príbovce, and Žabokreky reach between 500 and 1,000 model customers (1.9% in total). This is due to their central location and average size of the sales area. None of the other municipalities exceeds 500 model customers. Overall, approximately 8,100 shop in them, especially in Coop Jednota stores.

Intensity of customer potential

To compare the use of sales area capacity, we use a relative indicator intensity of customer potential, the value of which expresses the number of model customers per 100 m^2 of sales area either belonging to a specific retail chain (Table 2) or located in a specific municipality (Figure A8 in Appendix).

The Kaufland and Lidl brands have the highest intensity (268 customers per 100 m^2), and Tesco (251) and Billa (240) achieve comparable values. These chains have only one or a few stores in the region, which are located in the largest municipalities with a high probability of purchase. In contrast, we record a significantly lower intensity of the use of sales area (145) with the Coop Jednota retail chain. This is a consequence of the less effective historical development of the conditional distribution of the stores of this retail chain and, compared to others, the higher representation of its stores in smaller rural municipalities with reduced demand, as mentioned above. Meanwhile, superettes with smaller sales areas predominate among their stores (Mitríková 2008).

From the viewpoint of municipalities, Martin (268) and Turčianske Teplice (164) are characterised by the highest intensity of use of the sales area. These towns have a high affinity measure. The majority of model customers from other municipalities in the region go to them and carry out their convenience shopping there due to a better-equipped retail network. Furthermore, a drop in the frequency of daily convenience shopping and their shift to the so-called weekly (Spilková 2011, Križan et al. 2019) automatically means an increase in the volume of purchases and thus the motivation to shop in larger stores (usually in larger towns), even if they are more distant.

The higher intensity of customer potential in the municipalities of Košťany nad Turcom, Príbovce, Sučany, and Vrútky (125 to 150) is the result of a combination of their proximity to the largest population centre (Martin) and a relatively small sales area of their stores. We record low values of intensity (75 to 100) in municipalities in the central part of the region with a greater degree of peripherality owing to district towns and very low affinity. The stores in the remote municipalities in the south- and north-east of the region serve fewer than 75 customers per 100 m^2.

Conclusion

The model distribution of the probability of purchase and the customer potential of the Turiec region in Slovakia can be assessed from the perspectives of retail chains and the region's municipalities. Here, we summarise the main conclusions that ensue from the application of a modified Huff model in this region:

- For all the monitored chains, it is confirmed that they have the highest probability of a purchase mainly in those municipalities in which they have their stores located.
- We record the highest values of the probability of purchase for the Coop Jednota and Tesco stores.
- In the predominant majority of municipalities, it is true that their inhabitants most likely decide to shop in the town of Martin, while Turčianske Teplice draws customers from a much smaller circle of municipalities located in its immediate vicinity.
- The model pointed to a certain imbalance in the distribution of customer potential among the largest food retailers: while Tesco stores serve one-third of customer potential and Coop Jednota one-quarter; Kaufland, Billa, and Lidl are only attractive to about one in ten customers each.
- A comparison of the share of model customers with the share of sales area of individual retail chains shows a slight discrepancy in disproportions: while the share of Tesco customers is higher than its share in the total sales area, the opposite is true in the case of Coop Jednota.
- 79% of the region's customer potential is linked to the town of Martin, while Turčianske Teplice serves significantly fewer customers (7%); Vrútky has only one-hundredth of the customer potential of the region because of the large sales capacities in neighbouring Martin.
- The Coop Jednota chain has the widest network of stores in the region, which means that the area of its stores is used by customers with the least intensity, that is, only approximately two-thirds of customer numbers of other large chains per 100 m^2 of sales area.
- In the case of Coop Jednota, the intensity of the customer potential indicator reveals the under-dimensioned use of the sales area, and the high values of

this indicator in the remaining four chains can be interpreted as a possible insufficient satisfaction of the customer potential by the sales area.

- The high values of the intensity of customer potential in the towns of Martin and Turčianske Teplice indicate that there is still sufficient potential to expand the network of grocery stores.
- From the viewpoint of future expansion, the town of Turčianske Teplice, where two important retail chains operating in the Slovak market are missing, appears to be especially promising, as does Vrútky, which can profit from the great potential of customers in neighbouring Martin.
- We consider municipalities more distant from the main population centres with an intensity of the use of the sales area in the range of 100 to 125 customers per 100 m^2 to be risky in terms of the construction of another store.
- In the region, we identify a specific category of 19 municipalities without a food store, which, according to Bilková–Križan (2015) and Bilková et al. (2017), we can label it as a so-called rural food desert.

The innovative element of our approach is the incorporation of affinity in the Huff model, which accounts for daily commuter flows and thus allows us to capture the purchasing behaviour of the population more accurately. Our modification of the Huff model is easily replicable and flexible. It can be easily applied to other regions as well as to a larger or smaller set of retail chains. By adding a fictitious store or store to the calculation (with a specific size of sales area), it is possible to remodel the distribution of customer potential and assess the profitability of expanding the network of stores in specific locations. In contrast, by excluding some stores (for example, in the event of a planned departure of a retail chain from the market or in the event of the closure of certain operations in the interests of greater efficiency), where and to what extent customer potential shifts may occur can be monitored.

By multiplying the number of model customers by the volume of expenditures for food per capita (determined, for example, for regions of EU member states using the EU-SILC survey), we can estimate the expected retail turnover of individual establishments or entire retail chains. In this way, our model is also verified by applying it to the network of stores of a specific retail chain in another region and compare the model's estimated sales of its individual stores with the real sales, the size of which this chain made available to us. The predicted sales values of the model are 96%, consistent with the real sales.

However, it should be pointed out that our approach has some limitations that should be a subject of further research. One of the shortcomings of our approach is the overly simplified consideration of the spatial distribution of the population. Furthermore, we work on the level of municipalities which prevents us from achieving the results of such high accuracy as obtainable if we consider even smaller spatial units. This is particularly true for municipalities with greater populations. Higher-resolution spatial structures, such as grids (e.g. 1,000 × 1,000 m) or exact address points would allow us to significantly increase the accuracy. Similarly, another simplification is that we have only considered the road network, although the highly urbanised population tends to commute for shorter distances, including for 'small' purchases. For these purposes, people also tend to use public transport, bicycles, or walking. However, the accuracy of the estimates can be increased by further modification of the model, for example, by adding the feature of the attractiveness of the store. Nonetheless, the effect of the commuter flows could be accounted for in many different ways, and the incorporation of affinity in the model is only one of the options. Alternatively, we can consider the so-called 'agglomeration effect'.

At the theoretical level, this study offers a simple methodological tool that can be used particularly in the field of retail geography. From a practical viewpoint, it can be an efficient tool for conceptualising sales development strategies in a competitive struggle for the customer.

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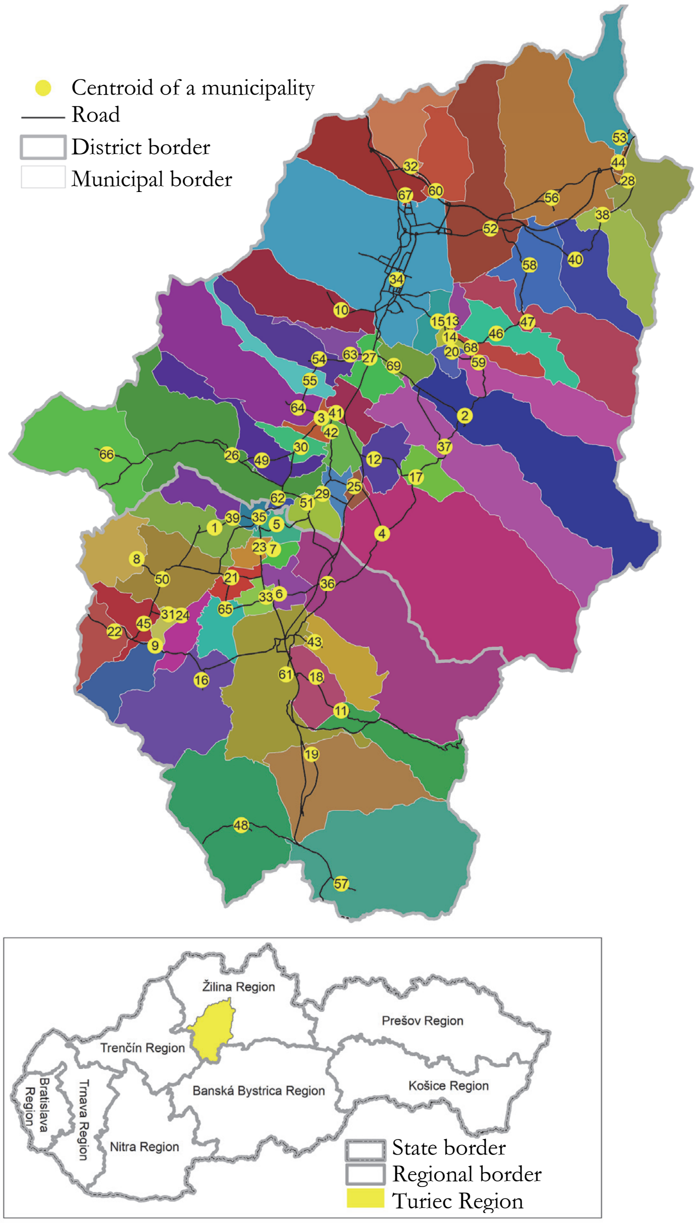
Appendix

Figure A1

Location and administrative division of the Turiec region in Slovakia, 2020

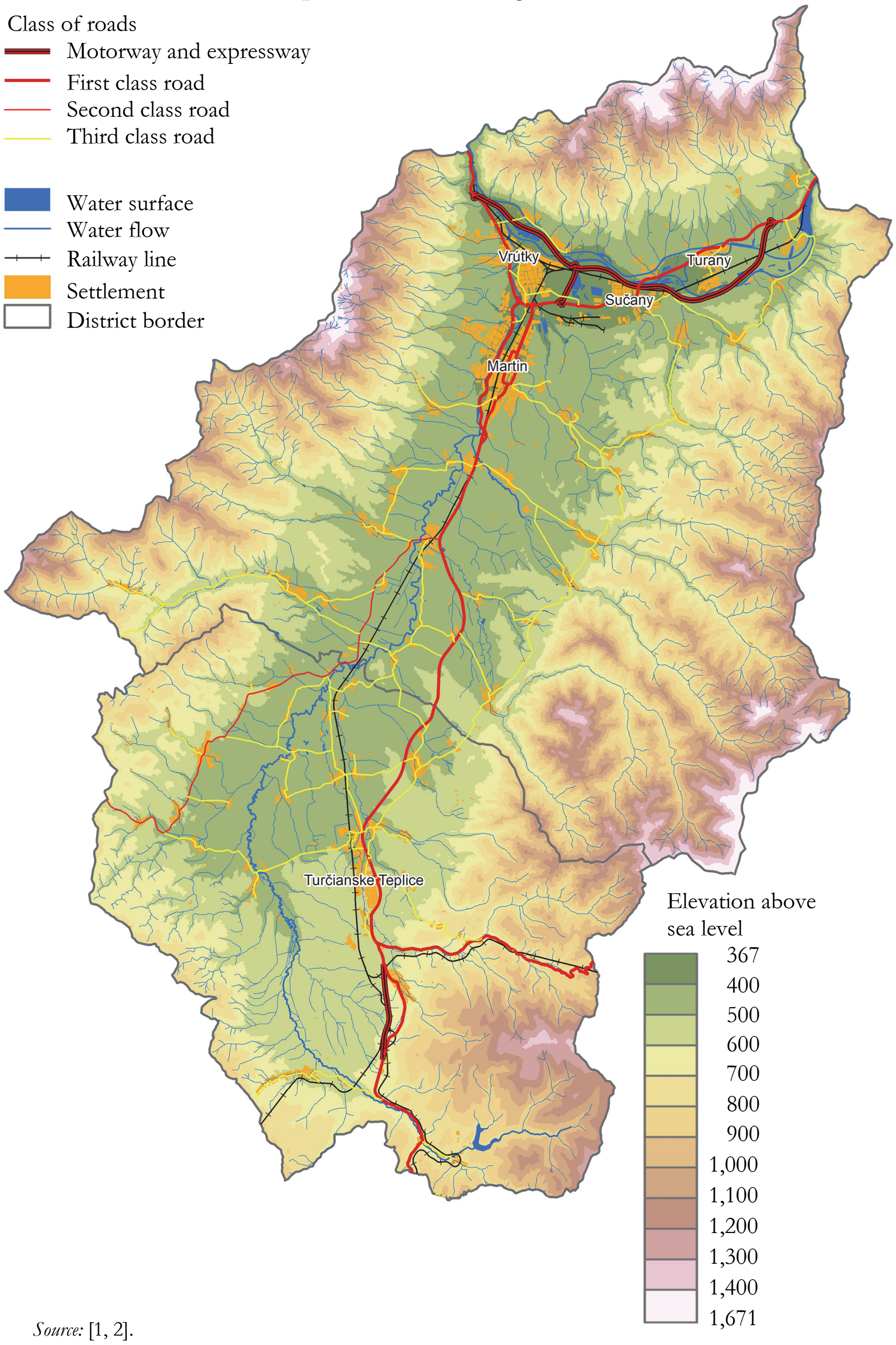


No.	Municipality name
1	Abramová
2	Belá - Dulice
3	Benice
4	Blatnica
5	Blažovce
6	Bodorová
7	Borcová
8	Brieštie
9	Budiš
10	Bystrička
11	Čremošné
12	Ďanová
13	Diaková
14	Dolný Kalník
15	Dražkovce
16	Dubové
17	Folkušová
18	Háj
19	Horná Štubňa
20	Horný Kalník
21	Ivančiná
22	Jasenovo
23	Jazernica
24	Kaľamenová
25	Karlová
26	Kláštor pod Znievom
27	Košťany nad Turcom
28	Krpeľany
29	Laskár
30	Ležiachov
31	Liešno
32	Lipovec
33	Malý Čepčín
34	Martin
35	Moškovec
36	Mošovce
37	Necpaly
38	Nolčovo
39	Ondrašová
40	Podhradie
41	Príbovce
42	Rakovo
43	Rakša
44	Ratkovo
45	Rudno
46	Sklabiňa
47	Sklabinský Podzámok
48	Sklené
49	Slovany
50	Slovenské Pravno
51	Socovce
52	Sučany
53	Šútovo
54	Trebostovo
55	Trnovo
56	Turany
57	Turček
58	Turčianska Štiavnička
59	Turčianske Jaseno
60	Turčianske Kľačany
61	Turčianske Teplice
62	Turčiansky Ďur
63	Turčiansky Peter
64	Valča
65	Veľký Čepčín
66	Vrícko
67	Vrútky
68	Záborie
69	Žabokreky

Source: [1, 2].

Figure A2

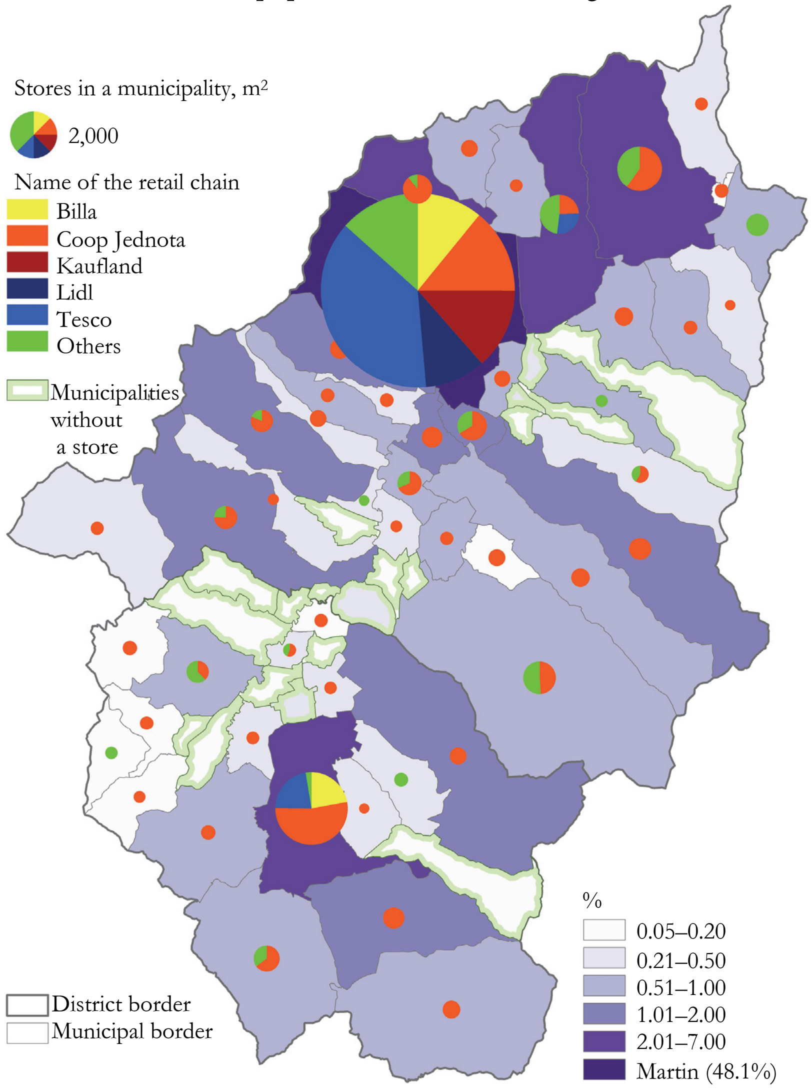
General map of the Turiec region in Slovakia, 2020



Source: [1, 2].

Figure A3

Structure of the network of retail food stores and spatial distribution of the population in the Turiec region in Slovakia, 2020

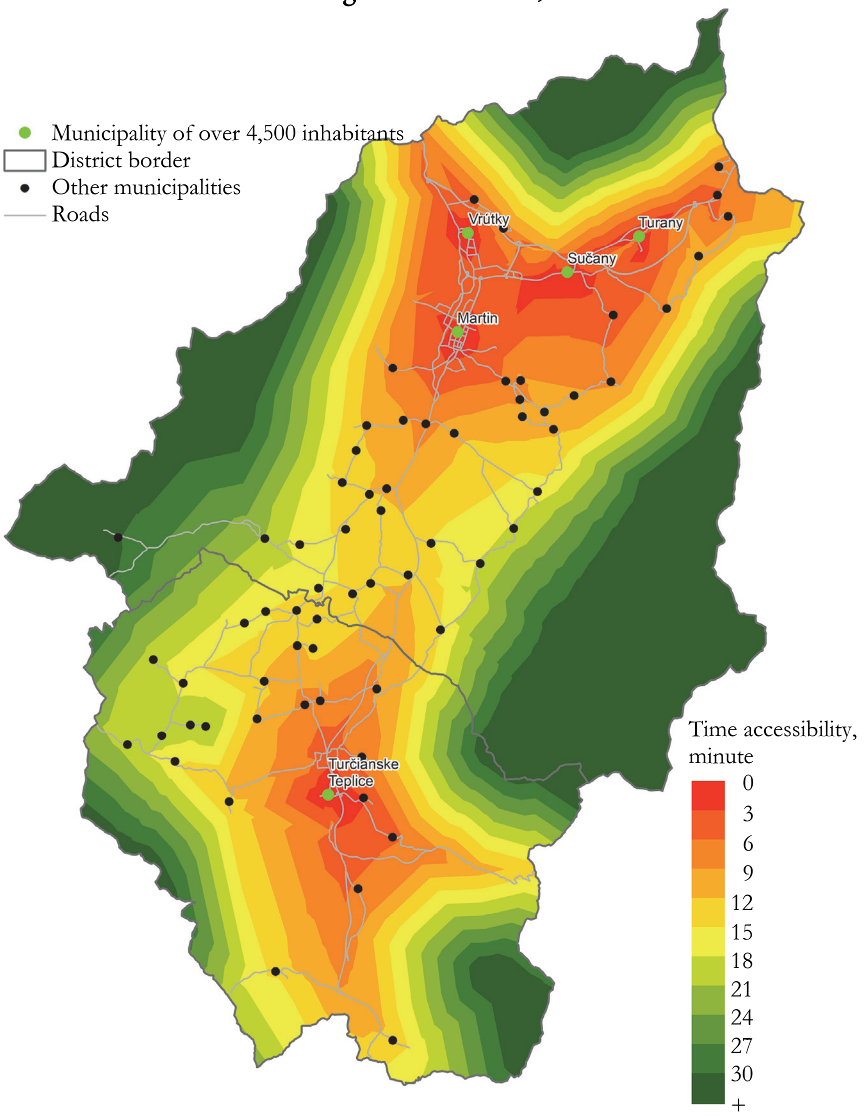


Note: Share of population = Number of inhabitants of a municipality/Number of inhabitants in the whole region.

Source: [1–3], authors' calculations.

Figure A4

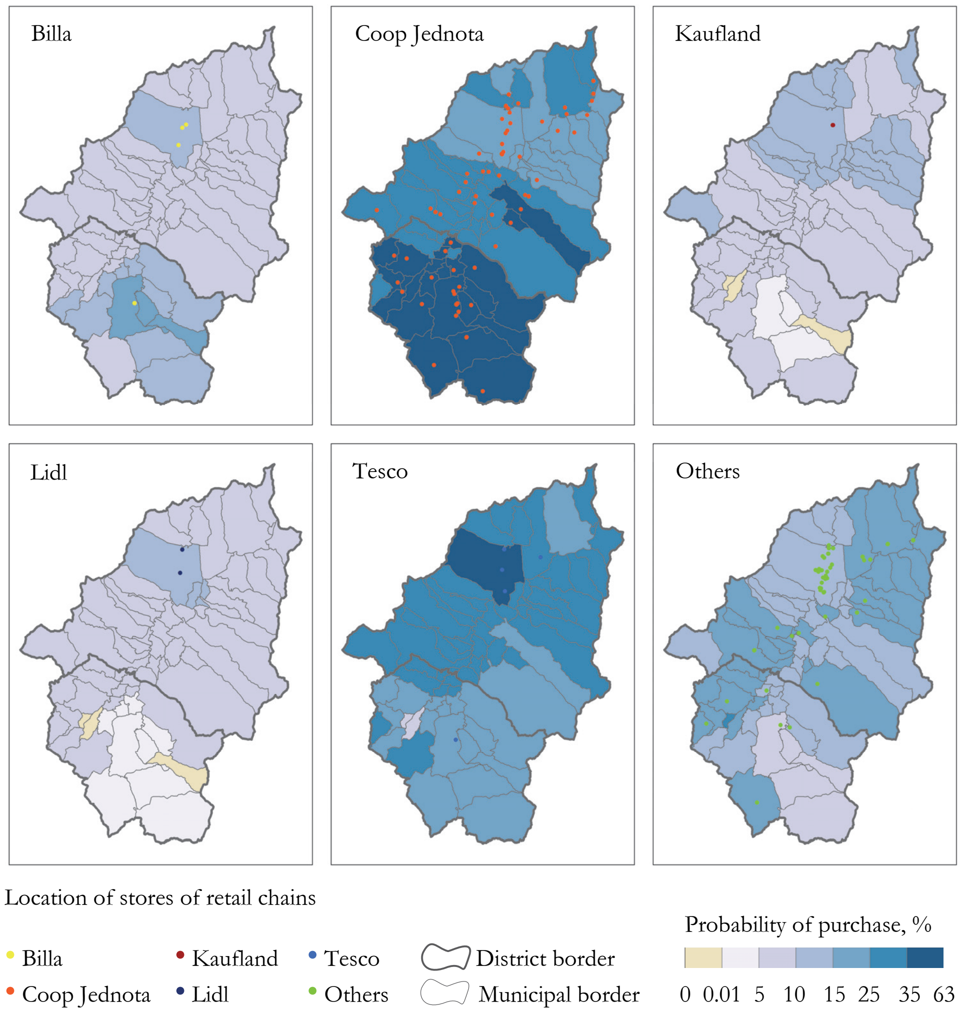
Travel time accessibility to the largest municipalities of the Turiec region in Slovakia, 2020



Source: [3], Stanek et al. (2021), authors' calculations.

Figure A5

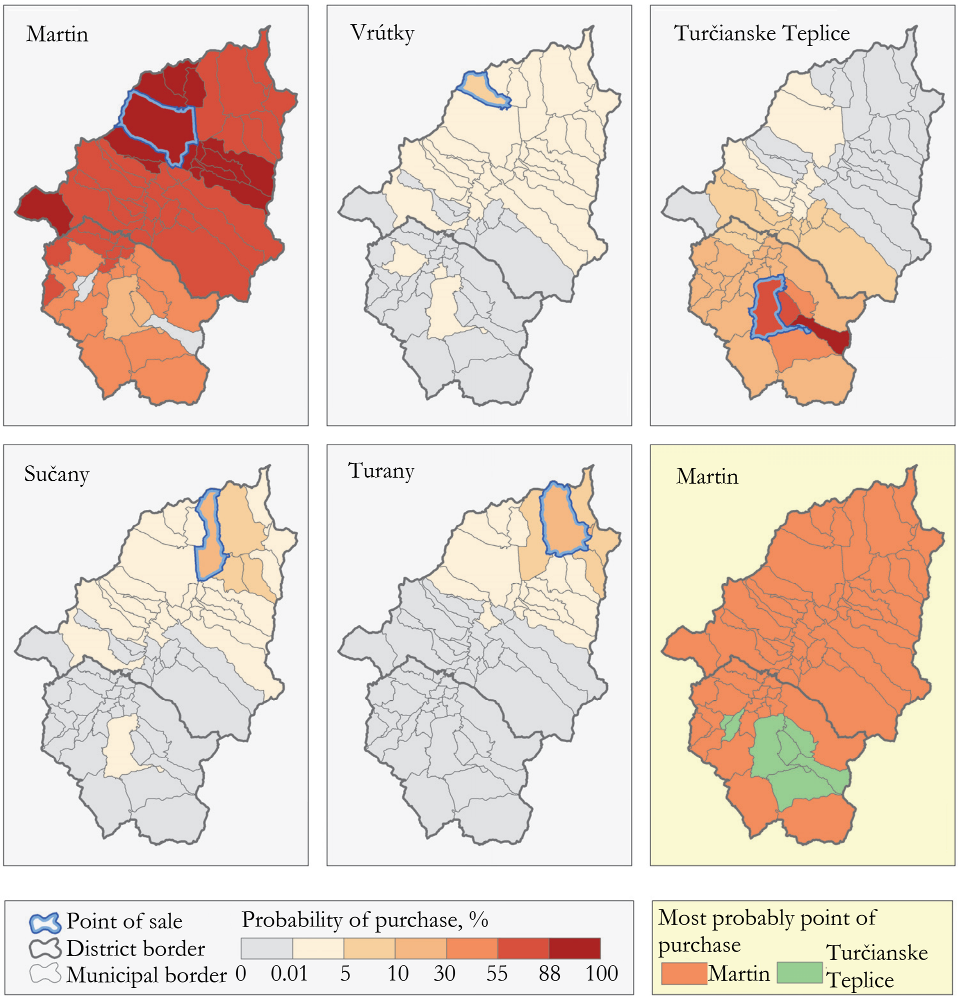
Probability of purchase by municipality inhabitants in the stores of selected retail chains in Slovakia, 2020



Source: [3, 6], Stanek et al. (2021), authors' calculations.

Figure A6

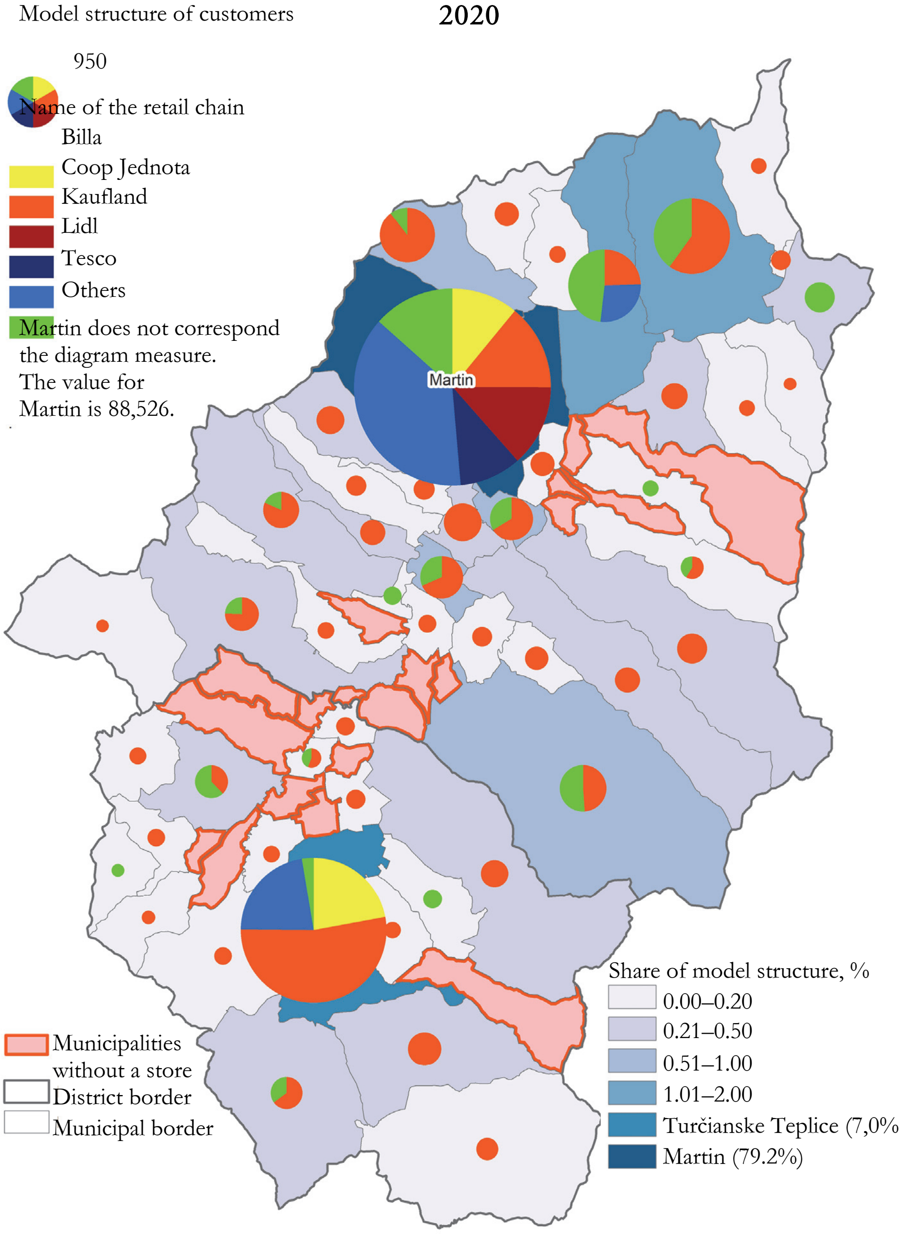
Probability of purchase of the residents of a municipality at selected points of sale in Slovakia, 2020



Source: [3, 6], Stanek et al. (2021), authors' calculations.

Figure A7

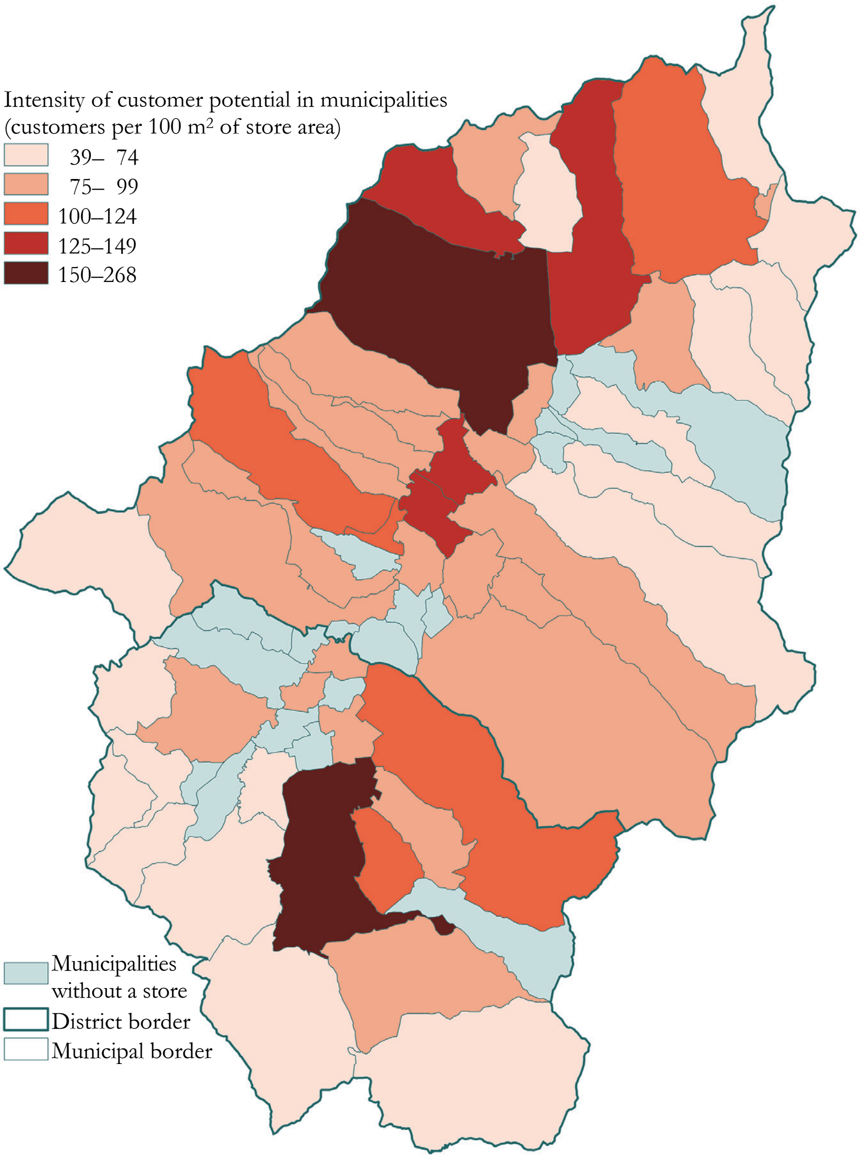
Customer potential in the municipalities of the Turiec region in Slovakia, 2020



Source: [1, 3, 6], Stanek et al. (2021), authors' calculations.

Figure A8

Intensity of customer potential in the municipalities of the Turiec region in Slovakia, 2020



Source: [1, 3, 6], Stanek et al. (2021), authors' calculations.

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INTERNET SOURCES

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