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The Effect of Grocery Store Openings on Residential Property Prices: Evidence from Morrisons Stores in England

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Table of Contents

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Title	The Effect of Grocery Store Openings on Residential Property Prices: Evidence from Morrisons Stores in England
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Abstract

This research focuses on the effect of supermarket openings on nearby residential property prices in England. Previously only a relationship in the US was established. I use data on residential property transactions in England, information about Morrisons supermarket openings from 2010 until 2013 and various neighborhood characteristics. To identify an association between the store openings and property prices, a difference-in-differences regression framework is used. While properties very close to stores do not increase in prices post-opening and announcement, the prices of properties 1 to 2-kilometer away increase by roughly 5 percent after the announcement. The reason why specifically close properties are unaffected, or in some subsamples even negatively affected, are most probable negative externalities such as traffic and construction noise or loss of green space cancelling out any accessibility benefits. It may also be true that there exists no impact for very nearby houses in the analyzed sample. For the radius of 1 to 2-kilometer, heterogeneity tests reveal that flats and apartments are especially affected with an impact of roughly 16% on property prices after announcement. Additionally, the found positive results hold for big but also rather small supermarkets. This study's findings may hold relevance for municipalities improving their understanding of the value of food stores and issuing planning licenses depending on the current food supply.

Keywords: Supermarkets, Property Prices, England, UK, Externalities, difference-in-differences

1. Introduction

Grocery stores may be the single most important daily amenity for many people: these stores offer a wide variety of key products needed for everyday life. Understanding if and by how much people value the presence of supermarkets is useful to determine whether the socially optimal number of supermarkets is present in a community. A high valuation may be interpreted as supermarkets being perceived as scarcely available and, therefore, highly appreciated, while a low valuation may point towards a sufficient food supply by supermarkets. If supermarkets create measurable value to a community, beneficial policies for all involved parties may be designed. To do so, the current situation regarding the value of food access must be better understood.

Store choice literature has provided knowledge on the utility a store's individuals attributes provide to consumers (e.g. Reutterer and Teller, 2008; Tang et al., 2001). In this line of research, a store's utility is typically approximated by the trips a customer takes to a store and the average spending per trip. Alternatively, customers are asked to rank various stores. While these strategies provide insight into the comparative utility among stores, it cannot provide the specific (monetary) value customers put on the access to a food store. An exact valuation is, however, necessary to not only understand which kind of store customers prefer but also if customers do value new stores. In comparison to shopping centers or other stores, customers are likely to visit supermarkets much more frequently. Therefore, the travel time to the next supermarket, the available choice of stores and other factors are likely to be of high significance when choosing a property to live in. Under the assumption that buyers acquire properties with the mix of attributes that maximize their utility, a close-by supermarket should be reflected in the price that people are willing to pay for a specific property when holding all other factors constant.

Understanding whether supermarkets have a significant impact on property values in various settings and across countries is important for mainly two aspects: First, as already hinted upon, an increase of nearby property prices may be a positive externality. While the supermarket chain makes the investment of opening and operating the store, the benefits are not only accrued by the chain but also by nearby residents. Welfare economics assumes that whenever social costs or benefits vary from the private costs the allocation of resources is not optimal (Pigou, 1932). If property prices increase after the opening of a grocery store, real estate investors and private house owners in the neighborhood benefit. In this case, research should focus on how to incorporate these externalities in the market to ensure its efficient functioning. For example, a neighborhood developer could understand whether renting out a key piece of the development to a supermarket is an attractive business decision. Second, from the viewpoint of a government (or policymakers) with strong interventionist planning permissions, supermarkets may be strategically given planning permission in specific places to control property prices. If a supermarket is positively valued, the attractiveness of neighborhoods can be increased.

Similarly, if planning authorities want to prevent a sharp change in property prices in some places, it is important to acknowledge and understand the impact that a supermarket would have on property prices. For these reasons, determining the valuation put on supermarkets in terms of property prices is this study's goal.

Multiple studies already analyzed the relationship between grocery stores and property prices, finding mostly positive effects for property prices (Pope and Pope, 2015; Slade, 2017; Ellickson and Grieco, 2013; Neumark et al., 2008). However, these studies are situated in the US and mainly focus on large supermarkets, often called supercenters, or primarily analyzed effects on the retail environment and the local labor market.

Three studies highlight the impact of the opening of a US supermarket on nearby property prices: Pope and Pope (2015) analyze the impact on residential house prices of the opening of a Walmart (Supercenter in the US). To overcome potential endogeneity of the location and timing of the Walmart openings, the authors employ a difference-in-differences analysis which compares housing prices before and after a Walmart opens for areas very close to a newly built Walmart, to areas further away. The authors find that housing prices within a 0.5-mile radius of a new Walmart increase by about 2-3 percent while houses between 0.5 and 1 mile from Walmart see an increase of 1-2 percent. Similarly, Slade (2017) examines the effect of new Walmart stores on the real estate market in the US with a difference-in-differences framework. In contrast to Pope and Pope (2015), Slade (2017) analyses the impact on land prices, instead of house prices, and finds a higher increase of 39 percent over the development period of the new Walmart. Lastly, in an unpublished study, Seangchote (2014) analyses the impact on property prices of the acquisition of Wild Oats Markets by Whole Foods (organic food store in the US), as well as the opening of Whole Foods stores at new locations. The author finds that the opening of a Whole Foods leads to an increase of 6.75 percent in property prices in areas closest to the store (precisely 0.5 miles). An Acquisition of a Wild Oats store led to an even stronger increase of 9.35 percent in property prices.

In Europe, no scientific study was found analyzing the relationship between property prices and supermarket openings. Nevertheless, for retail in general, several previous studies have found positive associations between shopping centers and house prices by using surveys (Sirpal, 1994; Des Rosiers et al., 1996; Emrath, 2002). The results achieved with these surveys are subjected to a variety of problems (e.g. self-selection of participants, no identification of causal effects). In this regard, Zhang et al. (2019) examine the effects of the redevelopment of inner-city shopping centers on property prices in the Netherlands with a difference-in-differences framework. Properties located next to a redeveloped shopping center increase on average by 1.43 percent just after redevelopment. Compared to the 6.75 percent found by Seangchote (2014) for Whole Foods supermarkets and the 2-3 percent found by Pope and Pope (2015) for Walmart, the relation seems, therefore, less strong for shopping centers compared to supermarkets. However, the fact that these shopping centers were not newly built but redeveloped may play a role in this outcome. Furthermore, the different study environments in Europe compared to

the US may play a significant role. That is why this study is also relevant for the present analysis. For a better understanding of the underlying mechanisms of the effect on property prices, it is of special interest whether the lower results arose because of the different amenities offered by a shopping center (i.e. cloths stores, cinemas and food courts) or because of the more densely populated and historically different city structure of European cities. European supermarkets are in most cases much smaller than their US competitors. The presented research in the US focuses mostly on the chain "Walmart" while European literature until now only analyzed the redevelopment of large shopping malls (Zhang et al., 2019). Because of that, the existing results cannot be transferred to European supermarkets.

To solve this research gap, the present analysis makes use of a hedonic pricing model in combination with a difference-in-differences framework allowing the identification of a relationship between supermarket openings and property prices in Europe. As a study area, England was selected because of existing non-scientific research by LLYOD Bank (2018). The bank reports property price premiums of up to £21.500 related to living close to a supermarket in the UK sparking reports in several newspapers (The Guardian, 2019; The Telegraph, 2015). However, the methodology is questionable; the release does not clearly explain how these values are derived. The authors seem to only compare areas with a supermarket to areas without a supermarket. This may lead to substantial biases: Supermarkets may be close to many other services which could be the true drivers of the price premiums. This leaves open the question: what is, in the European setting of England, the relationship between the opening of a supermarket and nearby residential property prices?

To achieve scientifically robust results, this study presents an advanced analysis of house prices utilizing the difference-in-differences framework. The framework tackles the problem of omitted variable bias by comparing the change in house prices in a treatment area, where a store opens, to a control area. As long as the development of house prices would have taken the same course in both areas if no store would have opened, the framework does not rely on including all possible auxiliary variables which can explain house prices (Angrist and Pischke, 2008). Data on store openings by the British supermarket chain "Morrisons" is combined with data on transaction prices of 92,217 nearby houses. The effect on prices is analyzed for houses at varying distances from the new store. Further, it is investigated whether the effect sizes differ for large stores, in areas that had bad supermarket access before the opening and depending on the type of affected property.

2. Theory

2.1 Understanding supermarket location

Especially for retail and grocery stores, the location choice is seen as the most critical factor for success (Clarkson et al, 1996). Underpinned by many classical theories, a supermarket chooses a new location by weighing of the expected income and the expected costs of each location. For example, Alonso (1960) proposes a model in which land use will depend on the most profitable use of each location. Concerning retail location choice, the theory predicts that a supermarket chain will choose the location which maximizes the difference between the income obtained from the store and the rent payable at each location. For the present analysis, this observation gives important insight into a situation which should be kept in mind: If the store is maximizing income with their location choice, supermarkets may choose areas in which property prices are already rising to maximize total profits, and not only operating profits from the day to day activities. Morrisons owns, compared to its rivals, a high percentage of its properties. Nonetheless, the company is offloading many properties and trying to move out of the property investment market (The Telegraph, 2014). While the company may have information on property price increases, a location is most likely chosen by comparing the income of the operating day to day business to the associated costs (Clarkson et al, 1996).

The fixed costs of operating a supermarket such as land, labor, equipment etc may differ immensely by the type of area (Ver Ploeg et al., 2009). From this perspective, it would make sense for supermarkets to mostly open up in areas with low property prices to reduce the costs connected with operating a supermarket. However, a supermarket chain may also try to maximize the expected income from a store by locating in wealthier neighborhoods in which people buy higher-end products.

Further insight gives spatial interaction theory which states that consumers trade-off the attractiveness of retailers against the distance needed to travel (Clarkson et al., 1996). For supermarkets, this means that stores which require customers to travel longer distances need to be additionally attractive in some form. For example, a supermarket located at the edge of a city may have to be significantly larger, offer special deals or give some other incentive to travel the distance. Thus, it is like that especially cheap or large stores are located at the edge of cities, while smaller and more expensive stores are located closer to their customers. These stores mainly attract customers by being the closest available opportunity to shop. In this regard, Morrisons is considering all locations from central to out-of-town (Morrisons Corporate, 2019). However, Morrisons' requirement of a plot size of at least 8,000 (to up to 20,000) square meters indicates that, in theory, out-of-town locations would be favored.

2.2 Accessibility and Negative Externalities

Supermarkets may affect house prices through either one of two ways: Positively through accessibility benefits or adversely through negative externalities (Pope and Pope, 2015).

On the one hand, since more than 90 percent of people in the UK still buy groceries at a local store, people are likely to value short distances to a grocery store (Statista, 2020). The short shopping distances result in less travel time and reduced costs of transport (e.g. fuel costs). Even if the opening does not result in lower travel times, a new supermarket chain in a neighborhood enlarges the possible choices: Customers can choose where they want to do their shopping based on criteria such as price, product variety and the overall experience. These gains are likely to be expressed in the prices of properties when holding all other factors constant.

On the other hand, the opening of a supermarket may also lead to negative externalities. A negative externality is a cost "[…] arising from any activity which does not accrue to the […] organization carrying out the activity" (Black et al., 2017). These negative externalities cause harm to people, organizations, or the environment through, for example, pollution or noise. The main channel for supermarkets is most likely the higher amount of traffic through which noise and pollution levels increase. Concerning the present study, this effect may be especially high since the analyzed supermarkets have a relatively large size and are located in very well by car accessible areas (Pope and Pope, 2015; Slade, 2017). Nevertheless, Morrisons stores are mostly located in industrial areas which are already characterized by rather large roads. Therefore, in theory, the additional traffic volume may be less noticeable. In the case of greenfield developments, the neighborhood loses green space which may be valued higher by some residents, particularly if green space is already scarce.

The discussion to this point leads to the conceptual model presented in Figure 1.

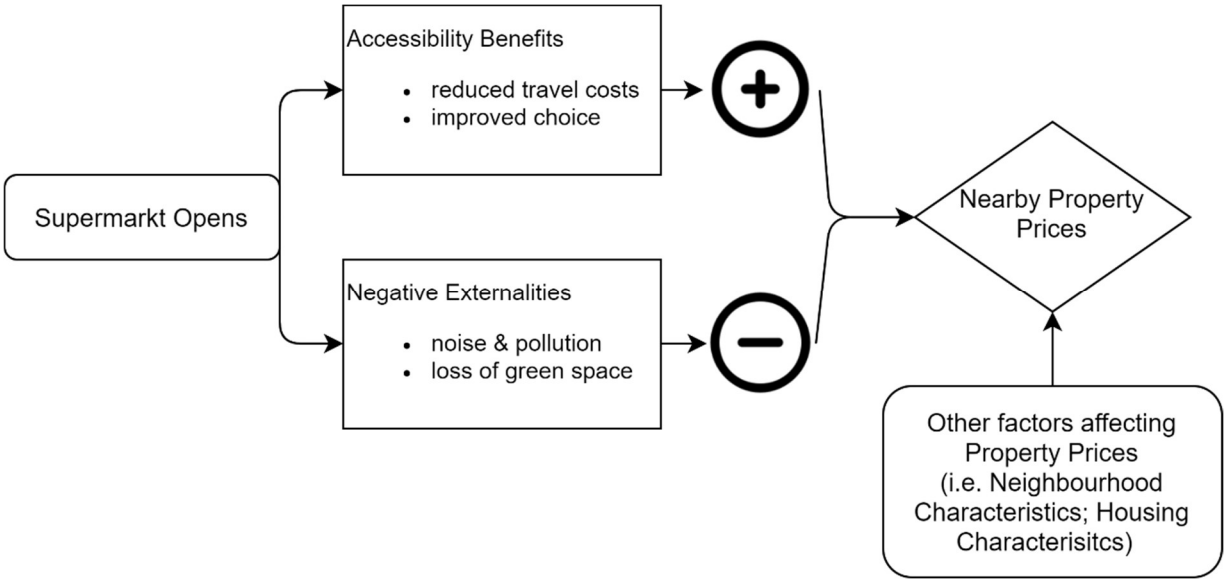

Figure 1 - Channels through which a supermarket opening may affect property prices

2.3 The Timing of impacts

It is unlikely that the previously described negative externalities and positive accessibility benefits all occur simultaneously with the opening of the supermarket. Instead, these effects may be spread over time. If the positive effects outweigh negative effects, the consequence may be a timeline of effects as described by Schwartz et al. (2006) and summarized in Figure 2:

First, as the negotiation between the supermarket and the city to obtain planning permissions starts, well-informed observers of the market may already realize the future increase in house prices. This could already lead to an increase in demand and prices. Second, an increase might occur when the development of the supermarket is announced in the local press or on the chain's website. At this point professionals who closely monitor the market can realize the increased value of surrounding properties. Third, property prices may further increase when the actual construction phase starts since existing uncertainty whether the development truly occurs is reduced to a minimum. Fourth, prices could increase after construction is finished when the supermarket is visible and accessible to the public. Lastly, in the coming years after the construction is finished the opening might attract additional stores and residents which, thereby, further increase property prices.

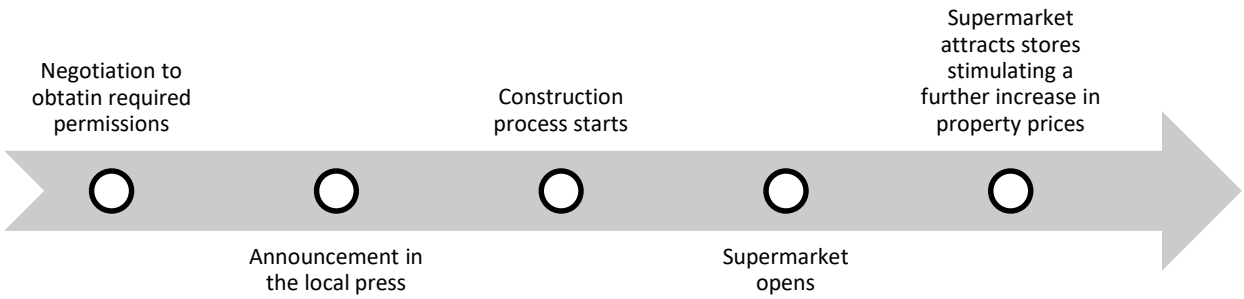

Figure 2 - Timeline of impacts on property prices

2.4 Hypothesis

Based on the theoretical discussion, as well as the discussed previously literature the main hypothesis can be developed that "*The opening and/or announcement of a supermarket lead to positive effects on nearby property prices."* It should be noted that the theoretical discussion suggests that the sign of the effects of supermarket developments is ambiguous. First, location theory does not give clear insight where supermarkets will open. Stores may open in neighborhoods with increasing property prices to earn these benefits or open in neighborhoods with low property prices to save on the payable rent. Second, the discussion of accessibility benefits and negative externalities provides reasons for opposing effects. However, due to the findings of previous literature, the accessibility benefit of supermarkets as an amenity is likely to be more important (Pope and Pope, 2015; Seangchote, 2014; Slade, 2017). The

literature consistently provided evidence for positive impacts of supermarkets on house prices. Further, after reviewing the timeline of a supermarket development, the effects are likely spread in time instead of occurring at the exact date of opening. Therefore, the opening and announcement date are included in the hypothesis.

3. Data and Methods

3.1 Methods: Hedonic Pricing and Difference-in-Differences

When buying a property, households implicitly pay for its characteristics such as its size, the number of bathrooms, the construction quality or locational characteristics such as the distance to the inner city, access to green spaces and the levels of criminal activity. The Hedonic Pricing Model proposes that the price of a good is a function of its attributes and allows to decompose prices of goods into implicit prices for their characteristics (Rosen, 1974). Therefore, this model could determine the implicit price of living close to a supermarket when included as an attribute.

However, when determining the added value of supermarkets, the results of this hedonic approach may be questionable. Omitted variables in the model may lead to substantial bias in the coefficient estimates (Pope and Pope, 2015). For example, if supermarkets are built in areas with high accessibility by public transport, the property prices could be higher due to the high accessibility. If no variable is included which identifies the accessibility, the coefficient of the impact of supermarkets is positively biased. Therefore, a purely hedonic approach could lead to biased results. To mitigate this concern of omitted variable bias, a difference-in-differences framework can be used (Pope and Pope, 2015). This quasi-experimental framework compares property transaction prices that are observed in *treatment areas* (close to a supermarket) to the property transaction prices in *control areas* (further from the supermarket). The key underlying assumption to achieve a meaningful result is that the trends in both areas would be the same if no supermarket had opened (Angrist and Pischke, 2008). All omitted variables must be either time-invariant group attributes *or* time-varying factors which are group invariant (Wing et al., 2018). These restrictions imply that the time series of average property prices for each group should differ by a fixed amount in all periods before the treatment. Figure 3 highlights how the effect of supermarket openings on property prices could be measured by this type of framework.

As already noted, the difference-in-differences framework is relatively robust compared to standard hedonic models, when confronted with omitted variables. However, as the property size is missing in the present study, problems may arise if the property size is correlated to another variable or the treatment group: For example, many Morrisons stores opened in industrial areas and in these neighborhoods residential buildings may, on average, be larger due to larger plot sites. If during the observed period large properties increase more in price than smaller properties, the found results may just measure this increase. While previous studies find that coefficients of the difference-in-differences key variables are sensitive when property characteristics are omitted, results did not change signs (Zhang et al., 2019). Therefore, and because there is no reason to assume different price trends depending on the property size, the results are assumed to still hold validity.

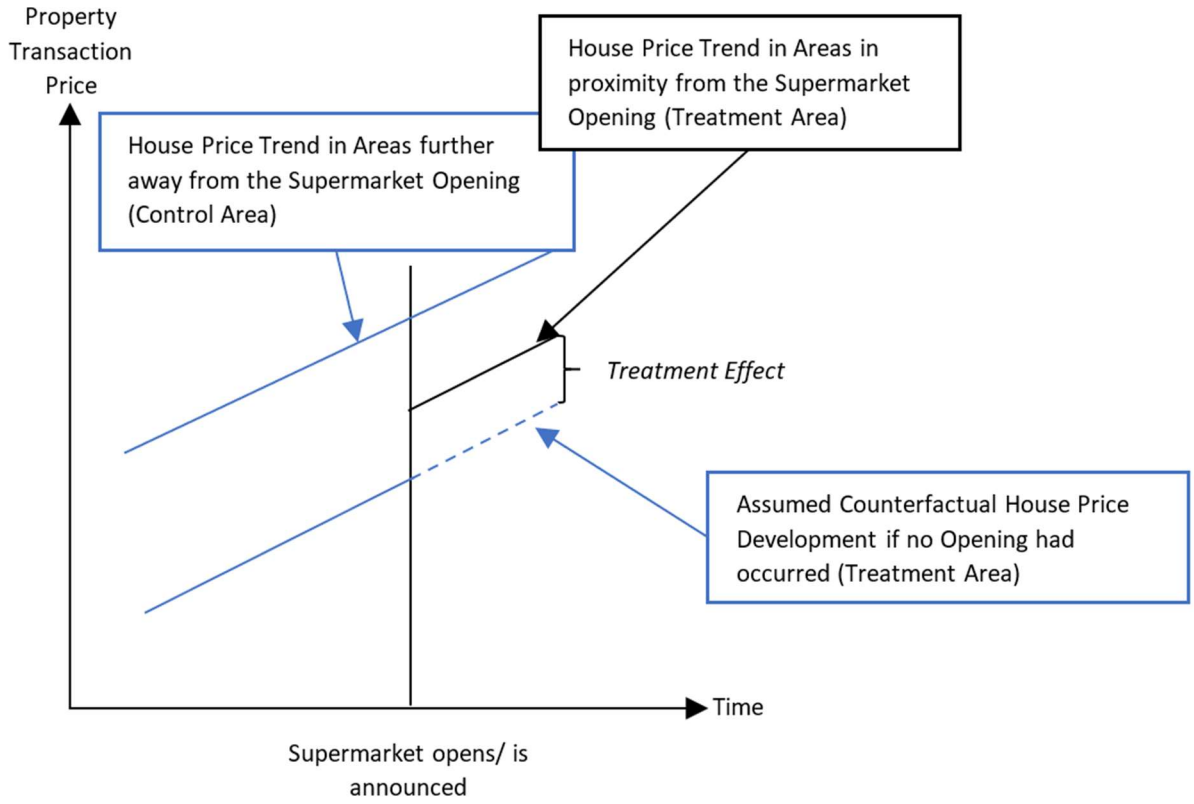

Figure 3 - Identification of possible causal effects in the difference-in-differences Framework for Supermarkets

An important issue when using this framework in the context of spatial analyses is how the treatment and control areas are defined. For supermarkets, Pope and Pope (2015) identified treatment areas around the supermarket of 0.5 miles (0.805 km), 0.5 to 1 mile (0.805 to 1.609 km) and 1 to 2 miles (1.609 to 3.22 km), while Slade (2017) even added one smaller treatment area of 0.25 miles (0.402 km) around the supermarket. One might argue that the accessible distances are higher in the US studies than in the present study in England due to the nearly double amount of vehicles per capita in the US (US Department of Transportation, 2019; Eurostat, 2019). Therefore, the impact could be even more localized in England. An analysis of all included stores with satellite pictures from Google Maps revealed that nearly all stores are in areas surrounded by factories or stores (especially in ~500-2,000 meters from the store). If the store is in the inner city, it was excluded from the analysis. Thus, it can be assumed that most shopping at the Morrisons stores in the sample is done by car. That is why very similar distances as in previous US studies were chosen with 0 to 1 km and 1 to 2 km from the supermarket opening. Since the observation size during this study is rather small only two distance bands were chosen. The control area includes property transactions in a radius of 2 to 4 km to the supermarket opening.

A further concern is the large geographic area in which the supermarkets opened: While some supermarkets opened up around London, others opened up in the North. The house prices in England differ significantly with much higher prices in the south compared to the north (Peachey, 2019). To

mitigate for these time-invariant omitted variables, spatial fixed effects for each opening are included. Furthermore, these effects are allowed to vary quarterly to control for the possible impact of time-varying spatial processes (similar to Pope and Pope, 2015; Slade, 2017 and Daams et al., 2019).
The following (1 is estimated:

$$\log(P_{ijt}) = \propto + \gamma_1 * PostOpening_{ij} + \sum_{k=1}^{2} \delta_k * Treatment_{ijk} + \sum_{k=1}^{2} \theta_k * Treatment_{ijk} * PostOpening_{ij} + \sum_{l=1}^{13} \beta_k X_{ki} + \omega_{tj} + \varepsilon_i \quad (1)$$

where $\log(P_{ijt})$ is the natural logarithm of the price of property *i* which is located within 4,000 meters from the new Morrisons store *j* and was sold in quarter *t*; $\propto$ is a constant; $Treatment_{ijk}$ is a vector of two dummies indicating whether property *i* is located within 1,000 meters or 1,000 to 2,000 meters of the new Morrisons store *j*; $PostOpening_{ij}$ is a dummy variable showing whether a property transaction occurred after the opening of the new Morrisons store *j*; $\sum_{k=1}^{K} \beta_k X_{ki}$ represents a set of control variables about each property such as whether the property is newly built or the type of neighborhood it is located in; ω_{tj} are store-by-quarter-by-year fixed effects; ε_i is an error term clustered at the Lower Layer Super Output Areas (LSOA) level, a neighborhood unit in the United Kingdom.

For the difference-in-differences approach, the key variables are the interactions of $Treatment_{ij}^{1{,}000m/\,2{,}000m} * Post_{ij}$. These equal to one if the property is in the treatment area *and* was sold after the supermarket opened. The coefficient measures the effect of the supermarket opening on property prices in the treatment area compared to the change of prices in the control area.

The theoretical discussion suggests, however, that the impacts may not necessarily occur at the time of the opening (see

2.3 The Timing of impacts). Thus, the $Post_{ij}$ dummy variable is additionally transformed to indicate a plausible date of the announcement of the development of a new supermarket.[1] Pope and Pope (2015) identified an average of 516 days of Walmart stores from announcement to opening by reviewing local Newspaper outlets. In the case of Morrisons' supermarkets, articles announcing new stores are scarce. The few articles that were found indicate a shorter development time which is why 365 days before the actual opening is chosen as the announcement of the supermarket. Since the announcement date could only be assumed the date is probably incorrect in some cases. It cannot be ruled out that this influences the outcome of the analysis.

[1] The effect may also be distributed over time and affect property prices before the public announcement or at each step of the development process. To understand the distribution of these effects, future studies should introduce time-varying treatment effects as described by Wing et al. (2018). Especially if data is available regarding the most important moments in time, as discussed in 2.3, accuracy may be increased.

By switching the opening date with the announcement date, equation 2 is also estimated:

$$\log(P_{ijt}) = \propto + \gamma_1 * PostAnnouncement_{ij} + \sum_{k=1}^{2} \delta_k * Treatment_{ijk} + \sum_{k=1}^{2} \theta_k * Treatment_{ijk} * PostAnnouncement_{ij} + \sum_{l=1}^{13} \beta_k X_{ki} + \omega_{tj} + \varepsilon_i \quad (2)$$

where $PostAnnouncement_{ij}$ indicates whether the transaction occurred after the plausible announcement date of the store.

3.2 Data on Supermarket Openings in the United Kingdom

To obtain data about recent openings of supermarkets in the United Kingdom, the eight largest supermarket chains based on market share, see Statista (2019), were contacted. Out of the eight, Tesco and Morrisons provided datasets. While Tesco's dataset does not contain exact opening dates, Morrisons' data offers dates on all openings from 2010 until 2013. Therefore, the analysis was done based on supermarket openings of the chain Morrisons.

Morrisons, often described as a mid-market supermarket, operates 491 stores, and has a grocery market share of roughly 10 percent in the United Kingdom (Stones, 2014; Statista, 2019). The company is part of the "big four" grocery retailers in the UK. In the period that was provided, Morrisons opened 54 new stores. Out of these 54 stores, three stores are excluded from the analysis since the opening date is missing. Also, since the analysis focuses on only England nine stores in Wales and Scotland are excluded. Using Google Maps Satellite Images, six additional supermarkets are omitted from all further analyses since these supermarkets are part of shopping centers or are located in the inner city. In these cases, any effects on real estate prices could not be traced back to the opening of the supermarket but may instead occur because of new cinemas, restaurants, or other shops. The final number of supermarkets included in the analysis is 36.

The store size in square meters is identified by measuring the outlines of the stores. The actual retail floorspace is likely smaller since the buildings also include storage, staff rooms, toilets etc. Since this is the case for all stores it should not introduce any bias. All numbers were rounded to 100 square meters.

When analyzing the structures with Google Street View, some properties appeared to be older than 10 to 15 years. Therefore, it is questionable whether all stores in the sample are newly opened or existed under a different chain before Morrisons' opening. However, it is very difficult to identify for which properties this is the case and Morrisons did not provide additional information.

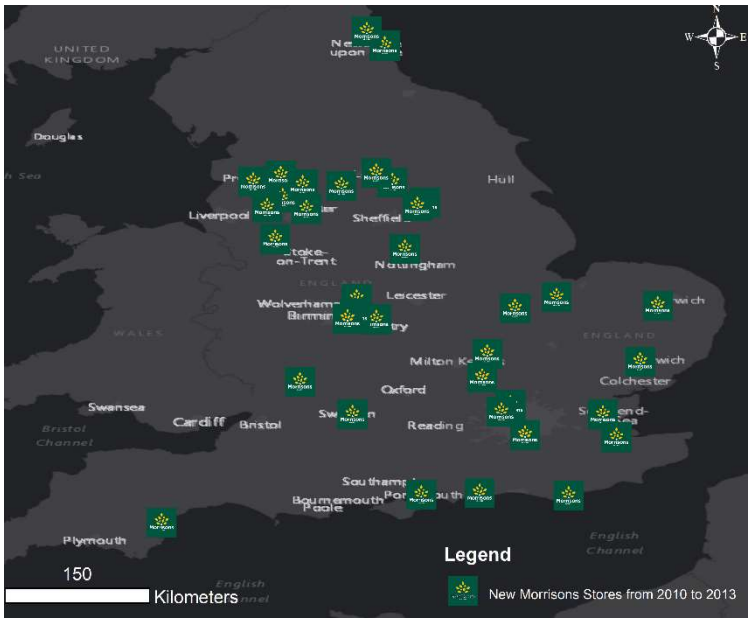

Figure 4 - New Morrisons Stores in England from 2010 to 2013

Finally, Figure 4 shows that the openings of Morrisons stores are distributed all over England. However, while Morrisons was previously mainly based in the North of England, the acquisition of Safeway in 2004 started the process of moving into the southern market (Morrisons Corporate, 2020). Therefore, many openings occurred in the south and center of England.

3.3 Real Estate Transaction Data

Real Estate transaction data is obtained from "Her Majesty's Land Registry" in the form of the Price Paid Dataset which contains data on property transactions for the full value and various property characteristics (HM Land Registry, 2020).[2] The dataset consists of only residential property transactions: all commercial transactions, sales which are not registered with the HM Land Registry and sales which are not for full value are excluded (HM Land Registry, 2020). Since the data is not geocoded, several additional steps were undertaken for the preparation for the analysis (see Appendix – 1 Geocoding of the Price Paid Dataset). After this process, as well as dropping outliers, the final number of transaction observations is 92,217.

In the dataset, residential properties are separated into four different property types (HM Land Registry, 2020; RICS, 2020): Detached houses are stand-alone structures which do not share walls with another property. Semi-detached houses share only one common wall with another building. Terraced houses are connected on two sides to other houses. Lastly, flats and apartments comprise self-contained premises which form a part of a building of which it is divided horizontally.

[2] It should be noted that hedonic pricing models consistently identified the size of a property as one of the most important explanatory variables; however, while the dataset includes several property characteristics it does not include the house/ plot size (Chin and Chau, 2003).

While the supermarket locations are not completely homogenous in their location within a city, a graphical analysis with the help of ArcMap and Google Maps revealed that many supermarkets are in districts at the outer skirts of cities. At proximity to these supermarkets, several property transactions took place, but, in many cases, larger parks, fields or industrial parks are located between the supermarket and the rest of the city. This may explain the rather low number of property transactions per square kilometer between 500 and 2,000 meters of the supermarket (about 300 per square kilometer compared to 1,500 per square kilometer close to the new store).

To further control for differences of the areas where the property transaction took place, neighborhood characteristics are used. The data is obtained from three different sources. First, the population density per 1-kilometer grid is collected for England (Eurostat, 2011). With a mean of 4,637 people per square kilometer, the sample includes many high-density areas even though the stores are mostly located at the outer skirt of cities. Second, several indices showing the deprivation level in the year 2010 for each of the 1,561 Lower Layer Super Output Areas (LSOA) in the sample are added to the analysis (Communities & Local Government, 2011). These indices include information about education deprivation, employment deprivation, crime deprivation, and are used as control variables to improve the explaining power of the model. The scores should not be interpreted and only indicate an ordinary order of the neighborhoods. Third, data about the accessibility of food stores in 2008, before the opening of any of the Morrisons stores in the sample, is obtained from the Department for Transport (2009). For each LSOA the data describes the time it takes to reach the next food store by foot which is used to divide the sample into neighborhoods with better and worse food access. The mean of 7,4 minutes as well as the low 75th percentile of 9,4 minutes highlight that even before Morrisons opened, food access in most areas was already very good.

The summary statistics presented in Table 1 examine the mean of all variables across the treatment groups and the control group. A comparison across the groups shows that the mean and standard deviation remain stable. This holds if the variables are further divided by before and after the announcement (see Table 6 in Appendix – 2 Summary table by the announcement date). While the sample size is sufficiently large in most cases, some exceptions exist. Specifically, models consisting of only Detached Houses or only Flats have only a few observations within 1,000 meters before the announcement date.

Table 1 - Descriptive Statistics for the Pooled Sample, the Treatment Groups, and the Control Group

	Pooled Sample (N=92,217)		Treatment Group 1,000 meters from store (N=1,358)		Treatment Group 1,000 to 2,000 meters from store (N=2,916)		Control Group further than 2,000 meters from store (N=87,943)	
	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Price in Pound	172,170	94,102.27	171,999	87,442.74	169,960	76,086.79	172,245	94,739.41
Population Density	4,636.84	2,814.324	4,749.395	3,049.066	4,729.496	2,627.855	4,632.03	2,816.468
Crime Deprivation Score	0.205	0.747	0.226	0.822	0.23	0.866	0.204	0.741
Education Deprivation Score	22.695	17.351	25.785	16.879	21.097	15.741	22.701	17.403
Environment Deprivation Score	25.237	17.179	26.904	18.92	24.688	18.182	25.229	17.115
Supermarket size in square meter	4,917.155	1,855.847	4,804.713	1,862.271	5,782.647	1,576.75	4,890.194	1,857.383
Time to next store (by foot, minutes, 2008)	7.372	5.556	7.298	3.401	6.954	3.644	7.387	5.634
Detached Houses	0.15	0.357	0.127	0.334	0.194	0.396	0.149	0.356
Flats and Apartments	0.187	0.39	0.143	0.35	0.224	0.417	0.187	0.39
Semi-Detached Houses	0.314	0.464	0.37	0.483	0.277	0.448	0.314	0.464
Terraced Houses	0.349	0.477	0.36	0.48	0.304	0.46	0.35	0.477
Newly built	0.085	0.28	0.049	0.215	0.114	0.318	0.085	0.279
Freehold	0.745	0.436	0.839	0.368	0.766	0.423	0.743	0.437
Leasehold	0.255	0.436	0.161	0.368	0.234	0.423	0.257	0.437

4. Results

The results for the models (1) and (2) are presented in Table 2. Both models, and all later models, show joint significance. As the models do not include information on the property size, the explanatory variables can only explain about 53.5% of the variation in property prices. The coefficients of property and neighborhood characteristics take on the expected signs.[3] Turning to the variables of interest for the difference-in-differences specification, model (1) utilizes the opening date to estimate Equation (1) i.e. it is assumed that the impact on property prices occurs with the opening of the supermarket. Most importantly, no variable of interest is significant. The largest coefficient is given by the interaction term of *PostOpening * Treatment 1,000m-2,000m*, indicating a positive effect on property prices in a radius of 1,000 to 2,000 meter from the store opening while remaining insignificant.

Table 2 - Estimation Results of the Main Specifications[3]

	(1)	(2)
	Pooled Model; Post Variable indicating the Opening	Pooled Model; Post Variable indicating the Announcement
PostOpening	-0.0000478	
	(-0.01)	
PostAnnouncement		-0.00681
		(-0.74)
Treatment 0m-1,000m	0.00212	0.0124
	(0.12)	(0.61)
Treatment 1,000m-2,000m	-0.00368	-0.0389*
	(-0.17)	(-1.92)
PostOpening * Treatment 0m-1,000m	-0.000276	
	(-0.02)	
PostOpening * Treatment 1,000m-2,000m	0.00786	
	(0.50)	
PostAnnouncement * Treatment 0m-1,000m		-0.0133
		(-0.81)
PostAnnouncement * Treatment 1,000m-2,000m		0.0497**
		(2.51)
Quarter-by-Year-by-Store Fixed Effects	Yes	Yes
Property Characteristics	Yes	Yes
Neighborhood Characteristics	Yes	Yes
Observations	92,217	92,217
Adjusted R^2	0.535	0.535
F Statistic	5,851.41***	5,853.02***

Note: Dependent Variable is the natural log of the property transaction price. All models include quarter-by-year-by-store fixed effects and the standard errors are clustered by each LSOA. *t* statistics in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Model (2) uses the same observations and radiuses but replaces the opening date with the announcement date (estimating Equation (2)). While all variables regarding the distances of 0 to 1,000 meters remain insignificant, the treatment area of 1,000 to 2,000 meters experiences significant differences to the control area. Since the dependent variable is the natural logarithm of price, the coefficients need to be transformed for interpretation (coefficient is interpreted as 100*(Exp(β)-1) percent; Halvorsen and

[3] The full models showing all property and neighborhood characteristics with definitions can be found in Appendix – 2 Full Regressions.

Palmquist, 1980). First, *Treatment1,000-2,000m* is weakly significant implying generally 3.82 percent lower property prices in a distance of 1,000 to 2,000 meters compared to the reference category of properties in a distance of 2,000 to 4,000 meters before the store opening. This may be attributed to the land use of these areas which was revealed by the visual analysis: In many cases, these are industrial areas, parks or fields (see 3.3 Real Estate Transaction Data). Second, the interaction term *PostAnnouncement * Treatment1,000m-2,000m* is highly significant: Properties that are at 1,000 to 2,000 meters from the supermarket site, sell at approximately 5.01 percent higher prices after the development is announced compared to the control area. Using the pooled sample mean for the price of £172,170, the results indicate a price premium of £8,626 for properties in 1,000 to 2,000 meters after the supermarket is announced to open.

4.1 Additional Investigations

In the following subsections, various variations of the introduced model (2) are theoretically motivated and estimated to check the sensitivity of the main results. This is done by examining the existence of noteworthy effects for certain subgroups of homes or supermarkets. As the Difference-in-Differences term in model (1) is insignificant and consistently remained insignificant throughout all tested subsamples (not shown here), the announcement date is used for analyzing the various subsamples by re-estimating Equation (2) in the models presented below.

4.1.1 Size of the new Supermarket

Previous studies were mostly done in the US where the average supermarket is much bigger than a typical European supermarket (Pope and Pope, 2015; Seangchote, 2014; Slade, 2017). Additionally, two of these studies focused on the particularly large chain Walmart. The supermarket chain Morrisons which is analyzed in the present study varies widely in its store size: the sample ranges from stores with a size of 1,100 sqm to up to 8,000 sqm. In comparison, Walmart's discount stores have an average size of 9,000 sqm, therefore, can be best compared to the largest stores in the sample (Walmart, 2020). For the present study, the size of the store may be important for several reasons:

First, the number of available products likely increases with the size of a supermarket. A large supermarket's selection decreases the need to go shopping in multiple supermarkets. This implies an increase in the derived accessibility benefits from the opening. For example, due to the higher availability of products, customers could do all their shopping at one store and do not have to go to a second supermarket. Second, the price image is found to be perceived lower for large supermarkets: The bigger size might signal that a store serves a large customer base and can obtain volume discounts from manufacturers (Brown and Oxenfeldt, 1972; Hamilton and Chernev, 2013). While the actual prices are the same in all Morrisons stores, the perceived price image still might play a role in improving the

anticipated value. Lastly, a large store might receive more media attention when opening and, therefore, simply be more noticed by residents and real estate investors.

Table 3 – Estimation Results for small and big supermarkets

	(3)	(4)
	Sub-Sample containing only small supermarkets (<5,000 sqm); Post Variable indicating the Announcement	Sub-Sample containing only big supermarkets (>=5,000 sqm); Post Variable indicating the Announcement
PostAnnouncement	-0.00784	-0.00403
	(-0.61)	(-0.31)
Treatment0m-1,000m	0.00599	0.0234
	(0.23)	(0.75)
Treatment1,000m-2,000m	-0.0218	-0.0487*
	(-0.87)	(-1.73)
PostAnnouncement * Treatment0m-1,000m	0.00488	-0.0361
	(0.21)	(-1.54)
PostAnnouncement * Treatment1,000m-2,000m	0.0405*	0.0607**
	(1.80)	(2.11)
Quarter-by-Year-by-Store Fixed Effects	Yes	Yes
Property Characteristics	Yes	Yes
Neighborhood Characteristics	Yes	Yes
Observations	45,911	46,306
Adjusted R^2	0.505	0.571
F Statistic	2,581.49***	3,407.54***

Note: Dependent Variable is the natural log of the property transaction price. All models include quarter-by-year-by-store fixed effects and the standard errors are clustered by each LSOA. *t* statistics in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Model (3) and (4) shown in Table 3 divide the sample by the size of the new store. As in the main model, the interaction term of *PostAnnouncement * Treatment1,000m-2,000m* is significant in both subsamples. For small stores (<5,000 square meters) property prices in a distance of 1,000 to 2,000 meters of the new store increase by 4.13 percent (p<0.1), while these prices increase by 6.26 percent (p<0.05) around large stores (>=5,000 square meters) compared to the control area. These results indicate a more pronounced result for larger stores. A detailed comparison of the coefficients (see Testing for Equality of Coefficients) shows that there is no statistically significant difference. The positive impact exists for both small and large stores without a significant measurable difference.

4.1.2 Food Supply Before Opening

The magnitude of the effect on property prices may depend on existing retailers already operating in the neighborhood. While some previously discussed accessibility benefits may also occur when there was already sufficient food supply (i.e. improved choice among store chains), a significant improvement in the distance to the next food store only arises if the area was previously undersupplied. If the food supply of a neighborhood is already sufficient, the impact on property prices may be much smaller.

This discussion can easily be underpinned by a Market Area analysis: Figure 5 shows one existing and one new supermarket. In the model, the y-axis displays the associated costs with travelling to the store and the x-axis shows a one-dimensional market (for a more extensive discussion of the assumptions see McCann, 2013). In Situation A the new store opens close to the already existing store while in Situation B the new supermarket opens in an area where currently no store exists.

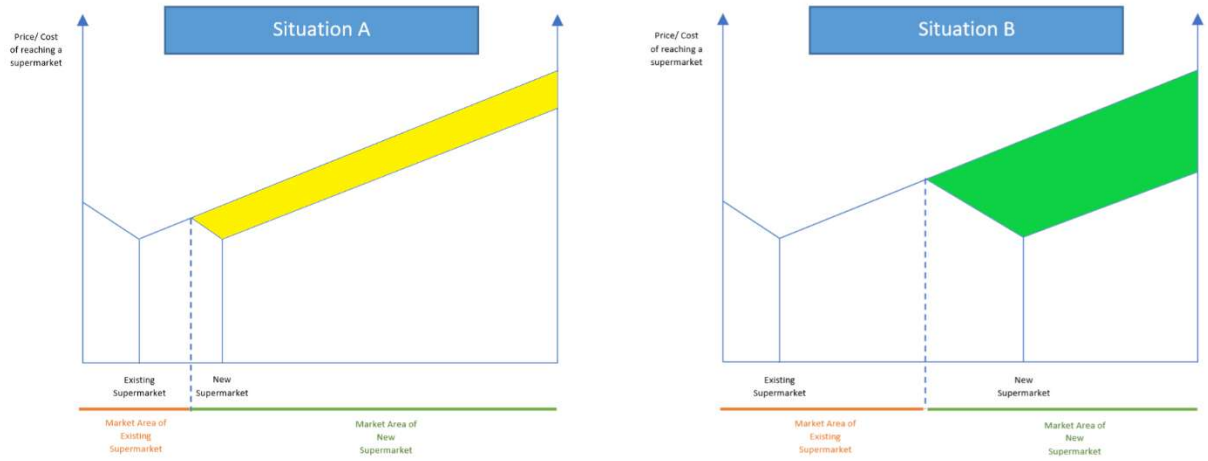

Figure 5 - Market Analysis for the opening of a new store depending on the prior food access

The costs of travelling increase with the distance to the supermarket, represented by the positive slopes into both directions from each supermarket (e.g. time, fuel costs). The colored areas show the decrease in travelling costs of reaching a supermarket in both situations after the new supermarket opens. Clearly, on average the decrease in costs for households in Situation B is far higher and this, in theory, should be reflected by a corresponding increase in house prices for the affected households. Further, a new supermarket in undersupplied areas may also be higher valued from a psychological perspective. Brock (1968) hypothesized any commodity being higher valued to the extent that it is scarce. Since then many studies have found empirical evidence for the theory (Lynn, 1991).

Model (5) and (6) which are shown in

Table 4 split the dataset by the travel time by foot to the next store *before* the Morrisons store opened i.e. model (5) shows only properties in locations where it took rather long to travel to the next store while model (6) includes only properties where even before Morrisons opened, it did not take long to travel to a food store.

Table 4 - Estimation Results divided by food access prior to Morrisons opening

	(5)	(6)
	Worst 50 percent of neighborhoods in terms of travel time to nearest food store by foot	Best 50 percent of neighborhoods in terms of travel time to nearest food store by foot
PostAnnouncement	0.00611	-0.0200
	(0.49)	(-1.51)
Treatment0m-1,000m	-0.0341	0.0498*
	(-1.34)	(1.85)
Treatment1,000m-2,000m	-0.0663**	-0.0104
	(-2.52)	(-0.46)
PostAnnouncement * Treatment0m-1,000m	0.0146	-0.0372*
	(0.63)	(-1.73)
PostAnnouncement * Treatment1,000m-2,000m	0.0420*	0.0502**
	(1.87)	(2.03)
Quarter-by-Year-by-Store Fixed Effects	Yes	Yes
Property Characteristics	Yes	Yes
Neighborhood Characteristics	Yes	Yes
Observations	46,178	46,039
Adjusted R^2	0.537	0.517
F Statistic	2,941.68***	2,705.69***

Note: Dependent Variable is the natural log of the property transaction price. All models include quarter-by-year-by-store fixed effects and the standard errors are clustered by each LSOA. *t* statistics in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

While the coefficient of *PostAnnouncement * Treatment0-1,000m* is not significantly different from 0 in Model (5), it is significant for neighborhoods with sufficient food supply. After the announcement, property prices in 1,000 meters to the opening decreased by 3.65 ($p<0.1$) percent compared to the control area. There is a significant difference between this coefficient for the two sub-samples (see Testing for Equality of Coefficients).

For both models (5) and (6), the coefficient of *PostAnnouncement * Treatment1,000-2,000m* is positive, significant and of a similar size. In areas with bad food access before the opening, property prices increased by 4.29 percent compared to the control area. No significant difference between the coefficients can be identified (see Testing for Equality of Coefficients). This may be explained by having a closer look at the travel time before Morrisons opened: The 99th percentile of the time it takes by foot to the next store is 14.5 minutes. Therefore, even most neighborhoods which are classified as having bad access before the opening do not have to travel longer than 1 to 2 kilometers before the opening. Thus, houses in both sub-samples and in 1 to 2-kilometre from the new store experience no changes in travel time. Instead the positive impact for both sub-samples may be driven by the additional variety in supermarkets.

4.1.3 Property Type-Based Submarkets

Several factors could be responsible for differing reactions in property prices for the various housing types introduced in 3.3 Real Estate Transaction Data following the opening of a supermarket. First,

detached houses have a much higher storage capacity compared to other types, especially flats and apartments. Therefore, people living in detached houses may go to supermarkets less frequently and value short distances to supermarkets lower. Second, detached, semi-detached and terraced houses provide, in most cases, parking spaces for their residents while this is less often the case for apartments and flats. Besides, there are differences in income between the various types: ONS (2017) found that terraced properties and flats were more affordable than detached properties. Thus, it may be the case that residents of terraced properties and flats have less often the financial capacity to buy a car.

Table 5 - Estimation Results divided by the type of transacted property

	(7)	(8)	(9)	(10)
	Subsample consisting of only **Detached** Houses	Subsample consisting of only **Semi-Detached** Houses	Subsample consisting of only **Terraced** Houses	Subsample consisting of only **Flats and Apartments**
PostAnnouncement	0.0309	-0.00887	0.0189	-0.0470**
	(1.30)	(-0.59)	(1.31)	(-2.03)
Treatment0m-1,000m	0.0526	0.0444	-0.00180	-0.0384
	(1.24)	(1.52)	(-0.07)	(-0.83)
Treatment1,000m-2,000m	-0.0615*	-0.0375	-0.0320	-0.0205
	(-1.76)	(-1.07)	(-1.31)	(-0.57)
PostAnnouncement * Treatment0m-1,000m	-0.0473	-0.0184	0.00172	-0.0534
	(-1.04)	(-0.73)	(0.06)	(-1.17)
PostAnnouncement * Treatment1,000m-2,000m	0.0186	0.0207	0.0465*	0.166***
	(0.55)	(0.71)	(1.93)	(3.84)
Quarter-by-Year-by-Store Fixed Effects	Yes	Yes	Yes	Yes
Property Characteristics	Yes	Yes	Yes	Yes
Neighborhood Characteristics	Yes	Yes	Yes	Yes
Observations	13,818	28,951	32,160	17,288
Adjusted R^2	0.185	0.291	0.289	0.164
F Statistic	200.94***	776.94***	857.96***	220.27***

Note: Dependent Variable is the natural log of the property transaction price. All models include quarter-by-year-by-store fixed effects and the standard errors are clustered by each LSOA. *t* statistics in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Model (7) – (10) presented in Table 5 break down the dataset by the type of property that was sold. The adjusted R^2 decreases substantially as the property type is homogenous in each sample and, therefore, cannot be included as an explanatory variable. None of the interaction terms of *PostAnnouncement* * *Treatment0-1,000m* is significant. Additionally, the interaction term of *PostAnnouncement* * *Treatment1,000-2,000m* is only significant for flats and terraced houses. Flats experience the highest impact measured during this study; after the announcement of a Morrisons store, property prices of flats in a distance from 1,000 to 2,000 meters from the store increased by 18.1 percent compared to flats in the control area. Using the average price of flats in the sample of £139,917, this corresponds to a price premium of £25,325. Even when accounting for the lower average selling price for flats, the effect is substantially higher than for the other property types. In comparison, for the same distances, the effect of Terraced houses is 4.76 percent which for the average price of £145,307 for Terraced houses results

in a price premium of £6,917. The effect on prices of flats is statistically significantly larger than the effect on Semi-Detached and Detached properties (see Testing for Equality of Coefficients) implying substantial differences between the impacts by the type of property. However, no difference could be found between Flats and Terraced houses.

5. Discussion

In the growing field of studies analyzing the effect of supermarkets on house prices, this research constitutes the first scientific analysis set in Europe. It provides information on how residents value the arrival of a supermarket based on real property transaction data. As the study proves the importance of access to supermarkets, it represents a new empirical contribution to the understanding of the housing market at the micro-level. While the exact effect remains ambiguous, it becomes clear that it depends on several other factors such as distance to the new store, prior food access and the type of housing.

Noteworthy is that, throughout all models and subsamples, the area of 1,000 to 2,000 meters from the new Morrisons store consistently shows positive effects on property prices. In contrast, for areas close to the new store no or even a negative effect is identified. Initially, this result might be counter intuitive as one would assume households closest to the store benefiting the most. Nonetheless, two reasons may be responsible: First, the results can be traced back to the arguments brought forward in the theoretical discussion regarding effects of accessibility and negative externalities (see 2.2 Accessibility and Negative Externalities). The positive accessibility gains for areas close to the supermarket are possibly outweighed by the negative externalities the supermarket may cause. These areas are probable to experience nuisance from the construction and, after completion, from increased traffic to the supermarket. In this regard, the negative effect for properties close to the new store in neighborhoods with good food supply before opening fits well (Model (6) and Figure 8). In these neighborhoods the benefit of an additional store may be marginal. While the new store increases the choice, it does not decrease the distance of travelling for food for most households. The negative externalities are, however, unaffected; construction noise, increased traffic and loss of green space can still be a consequence of the opening. These externalities only affect very close properties: households further than 1 kilometer from the development do most likely not notice any changes in traffic and are undisturbed by the construction noise. Second, the low number of observations may play a further role. However, while there are only 295 transactions that occurred in 0 to 1,000 meters of a supermarket opening before the announcement, studies with a similar design used a comparable number of observations and still identified significant impacts. But this also might be the case due to a different spatial setting or the inclusion of more housing characteristics (Sah et al., 2015; Slade, 2017). In this regard, the residual plot in Figure 8 utilizing the subsample of only properties with good prior food access exhibits strong volatility, possibly caused by the low observation size and the low predictive power of the model. Nevertheless, the trends are clear; close by properties decreased in price while properties further away increased in value.

While for larger stores the positive externalities the store may cause on property prices is higher in 1,000 to 2,000 meters, further tests show that the difference is not significant. Nevertheless, these results in combination with the underlying theoretical arguments indicate that there may be a significant difference to smaller stores. The residual plot in Figure 7 further demonstrates the relatively low

volatility and the more consistent pattern of parallel trends before the announcement, at least compared to the other residual graphs. More importantly, the results add to the current literature by confirming the benefits of small food providers, even if these benefits might be relatively smaller. Small stores improve the available choices between supermarket chains and, at least for some households, decrease the time to travel to the next supermarket. These benefits seem unaffected by the size of the supermarket.

The positive effect on flats is far more pronounced than on all other property types. These results are a first indication on which people may benefit the most from a new supermarket. Several reasons were discussed why such a relationship can exist (see 4.1.3 Property Type-Based Submarkets). Nevertheless, the missing detail in the dataset denies conclusions on the underlying mechanisms. Moreover, some non-significant coefficients for other housing types may be caused by the low observation size within 1,000 meters (see 3.3 Real Estate Transaction Data).

As there are only two published studies which have had a similar goal and used a difference-in-differences framework, a comparison is meaningful. Compared to Slade (2017) who is only able to find significant impacts on commercial properties, this study found significant results for residential areas. The identified impact by Slade (2017) is decaying with distance to the opened store while for the present study the impact on close properties is negligible and increases with distance to the store. Possibly, agglomeration benefits for commercial real estate are the reason why the effect decays with distance in Slade's (2017) study, while for residential properties the negative externalities directly next to the store outweigh any benefits. Currently, no European study analyzed the spillover effects for commercial real estate. Furthermore, the effect identified by the author is with a value of 39 percent over the development period of the new Walmart far higher than any impacts encountered during this study. In the case of supermarkets which attract a lot of customers to an area, spillover effects may be particularly high and should be researched in future studies. The difference to Slade (2017) may not only be explained by the commercial real estate but also by the use of land values instead of property values. There has been rising recognition of the differences between land values and real estate values as a whole. Land values are more affected by external demand shocks and, therefore, experience more volatile price changes (Krause and Bitter, 2012).

Pope and Pope (2015), who only use residential housing data, identify a decaying effect with distance to the new store. The impact is in size comparable to the results of the present study with the main difference being that effects are found for very close properties only. To identify whether the effect decays with distance after its initial peak, future research should test larger distance buffers for significance. The opposing result in the US suggests that negative externalities of the new store possibly do not play a significant role in the US while they do in England. Cultural differences, mainly regarding urban planning, between the US and England may be a reason why the effects differ. The average population density surrounding a Walmart store is 324 residents per square kilometer (Ellickson and Grieco, 2012). In contrast, during this study, the average number of residents close to a Morrisons store is more than ten times higher with 4,637 residents per square kilometer. This observation suggests that

in England properties are smaller, located closer to streets and closer to the construction site, strengthening the nuisance experienced by higher traffic volumes and construction noise. In these high-density areas, the possible loss of green space is harder to bear if green space already is scarce. Another possibility is that there is already an abundance of supermarkets in England, while these are rather scarce in the US due to the lower population density. Therefore, people are likely to travel longer distances in the US before the opening. These reasons may explain the non-existent or even negative impact on property prices in England compared to Pope and Pope's (2015) findings.

6. Conclusions

The study set out to find the impact of supermarket openings on property prices in the England. Generally, the impact is non-existent, or even negative when there is already sufficient food supply for properties very close to a new store, and instead mostly confined to properties in 1,000 to 2,000 meters of the store. In the various sub-samples, the identified impact ranges from coefficients that are not significantly different from 0 (e.g. detached houses) to up to 18.1 percent for flats. These results could be explained by the negative externalities (traffic and construction noise, loss of green space) experienced by close households while households further away from the opening only experience the benefits of having an additional daily food provider. When interpreting these results, the assumed announcement date should be kept in mind. No real information about the announcement of each supermarket was available, leading to possible inaccuracies.

In practice, after thoroughly reviewing the results of the present study with other English supermarket chains, municipalities should be made aware of what the consequences are of issuing planning licenses for areas with good supermarket access. In these cases, residents possibly do not want or need another supermarket resulting in a negative response of property prices. Instead, supermarkets could be urged to open in undersupplied areas.

References

Alonso (1960). A Theory of the Urban Land Market. *Papers and Proceedings of the Regional Science Association, Vol 6*

Angrist J. D. and Pischke J.-S. (2008). Mostly Harmless Econometrics: An Empiricist's Companion. *Princeton University Press*

Black, J., Hashimzade, N. and Myles, G. (2017). A dictionary of economics (5th ed., Oxford quick reference) [5 ed.]. Oxford: Oxford University Press.

Brock, C. (1968). Implications of commodity theory for value change. *Psychological Foundations of Attitudes:* pp. 243-275

Brown, F. E. and Oxenfeldt, A. R. (1972). Misperceptions of Economic Phenomena. Sperr & Douth, Inc New York.

Chin, T. L. and Chau, K. W. (2003). A critical review of literature on the hedonic price model. *International Journal for Housing and Its Applications 27(2):* pp. 145-165

Clarkson, R. M.; Clarke-Hill, C. M. and Robinson, T. (1996). UK supermarket location assessment. *International Journal of Retail & Distribution Management* Vol. 24 No. 6: pp. 22-33

Communities & Local Government (2011). English indices of deprivation 2010. *Neighbourhoods Statistical Release.* Retrieved on 18.04.2020 from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/6871/1871208.pdf

Daams, M. N.; Proietti, P. and Veneri, P. (2019). The effect of asylum seeker reception centers on nearby house prices: Evidence from The Netherlands. *Journal of Housing Economics 43*

Department for Transport (2009). 2008 Core Accessibility Indicators. Retrieved on 19.04.2020 from https://webarchive.nationalarchives.gov.uk/20120207140011/http://www2.dft.gov.uk/pgr/statistics/datatablespublications/ltp/coreaccessindicators2008.html

Department of Transport Statistics (2019). Household car ownership by region and Rural-Urban Classification: England, 2002/03 ownards. *National Travel Survey.* Retrieved on 13.04.2020 from

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/821513/nts9902.ods

Ellickson P. and Grieco P. (2013) Wal-Mart and the Geography of Grocery Retailing. *Journal of Urban Economics 75:* pp. 1-14

Des Rosiers, F.; Lagana, A.; Theriault, M. and Beaudoin M. (1996). Shopping centres and house values: an empirical investigation. *Journal of Property Valuation and Investment Vol. 14 No 4:* pp. 41-62

Emrath, P. (2002). Explaining Housing Prices. *Housing Economics*: pp. 9-13

Eurostat (2011). GEOSTAT 1km2 population grid. Retrieved on 01.04.2020 from https://ec.europa.eu/eurostat/web/gisco/geodata/reference-data/population-distribution-demography/geostat

Eurostat (2019). Passenger cars in the EU. Retrieved on 08.04.2020 from https://ec.europa.eu/eurostat/statistics-explained/index.php/Passenger_cars_in_the_EU#Overview

Halvorsen, R. and Palmquist, R. (1980). The interpretation of dummy variables in semilogarithmic equations. *American Economic Review 70(3),* pp. 474-475

Hamilton, R. and Chernev, A. (2013). Low Prices Are Just the Beginning: Price Image in Retail Management. *Journal of Marketing Vol. 77* pp. 1-20

HM Land Registry (2020). HM Land Registry Open Data. Retrieved on 17.02.2020 from https://www.gov.uk/government/statistical-data-sets/price-paid-data-downloads

Krause, A. L. (2012). Spatial econometrics, land values and sustainability: Trends in real estate valuation research. *Cities pp. 19-25*

Lloyds Bank (2018). Homes close to a supermarket can boost house prices by more than £21,000. Retrieved on 12.11.2019 from https://www.lloydsbankinggroup.com/Media/Press-Releases/2018-press-releases/lloyds-bank/090618_Supermarkets_LB/

Lynn, M. (1991). Scarcity effects on value: A quantitative review of the commodity theory literature. *Psychology & Marketing 8(1),* pp. 43-57

McCann, P. (2013). Modern Urban and Regional Economics. *Oxford University Press*. Second Edition. Chapter 1.4.

Morrisons Corporate (2019). Morrisons requires conveniently located sites nationwide for new store growth. Retrieved on 22.05.2020 from https://www.morrisons-corporate.com/globalassets/corporatesite/about-us/propertydownloads/morrisons_property_ad_a4_v2.pdf

Morrisons Corporate (2020). About us: Company History. Retrieved on 17.12.2019 from https://www.morrisons-corporate.com/about-us/company-history/

NSPL (2011). National Statistics Postcode Lookup (August 2011). *Office for National Statistics*. Retrieved on 4.3.2019 from https://data.gov.uk/dataset/7e817fd1-6f2c-4667-b057-0f829864b8aa/national-statistics-postcode-lookup-august-2011

Neumark D., Zhang, J. and Ciccarella (2007). The effects of Wal-Mart on local labor markets. *Journal of Urban Economics 63: 405-430*

Peachey, K. (2019). North-South divide in house prices. *BBC Business*. Retrieved on 11.04.2020 from https://www.bbc.com/news/business-48363795

Pope, D. and Pope, J. (2015). When Walmart Comes to Town: Always Low Housing Prices? Always? *Journal of Urban Economics 87:* 1-13

Pigou, A. C. (1932). *The Economics of Welfare*. Fourth Edition. MacMillian and Co.

Reutterer, T. and Teller, C. (2008). Store format choice and shopping trip types. International Journal of Retail & Distribution Management Vol. 37 No. 8.

RICS (2020). Residential property types definitions. *Royal Institution of Chartered Surveyors*. Retrieved on 11.04.2020 from https://www.ricsfirms.com/glossary/residential-property-types-definitions/

Rosen, S. (1974). Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition. *Journal of Policitical Economy* 82(1): pp. 34-55

Sah, V.; Conroy, S. J. and Narwold, A. (2015). Estimating School Proximity Effects on Housing Prices: the Importance of Robust Spatial Controls in Hedonic Estimations. *The Journal of Real Estate Finance and Economics 53:* pp. 50-76

Schwartz, A. E.; Ellen, I. G.; Voicu, I. and Schill, M. H. (2006). The external effects of place-based subsidized housing. *Regional Science and Urban Economics 36*: pp. 679-707

Seangchote, K. (2014). Positive Externalities in the Real Estate Market. *Department of Banking and Finance, Chulalongkorn Business School*

Sirpal, R. (1994). Empirical Modeling of the Relative Impacts of Various Sizes of Shopping Centers on the Values of Surrounding Residential Properties. *Journal of Real Estate Research* 9(4): pp. 487-505

Slade, B. A. (2017). Big-Box Stores and Urban Land Prices: Friend or Foe?. *Real Estate Economics*: *pp. 7-58*

Statista (2016). United Kingdom: grocery channel retail value share 2016-2021. *Statista Research Department.* Retrieved on 4.3.2019 from https://www.statista.com/statistics/611045/grocery-retail-channel-share-united-kingdom-uk/

Statista (2019). Grocery market share in Great Britain 2015-2019. Published by Nils-Gerrit Wunsch. Retrieved on 18.02.2020 from https://www.statista.com/statistics/280208/grocery-market-share-in-the-united-kingdom-uk/

Stones, M. (2014). The “Morrisons effect” hits UK retailers. Food Manufacture, 89(4), 11.

Tang, C.; Bell, D. and Ho, T. H. (2001). Store Choice and Shopping Behavior: How Price Format Works. California Management Review 43(2).

The Guardian (2019). Does a local Lidl really bring down house prices? *Written by Sarah Butler*. Retrieved on 27.12.2019 from https://www.theguardian.com/business/shortcuts/2019/jul/31/does-lidl-bring-down-house-prices-waitrose

The Telegraph (2014). Morrisons to sell £500m of its properties as fightback begins. *Written by James Quinn and Ben Martin*. Retrieved on 22.05.2020 from https://www.telegraph.co.uk/finance/newsbysector/retailandconsumer/10685519/Morrisons-to-sell-500m-of-its-properties-as-fightback-begins.html

The Telegraph (2015). Living near a Waitrose 'puts £38k on value of your home'. *Written by Agency.* Retrieved on 27.12.2019 from https://www.telegraph.co.uk/news/shopping-and-consumer-news/11512665/Living-near-a-Waitrose-puts-38k-on-value-of-your-home.html

US Department of Transportation (2019). Highway Statistics 2017 – State Motor-Vehicle Registrations. Retrieved on 08.04.2020 from https://www.fhwa.dot.gov/policyinformation/statistics/2017/mv1.cfm

Ver Ploeg, M.; Farrigan, T.; Breneman, V. and Hamrick, K. S. (2009). Access to Affordable and Nutritious Food – Measuring and Understanding Food Deserts and Their Consequences: Report to Congress. *United States Department of Agriculture*

Walmart (2020). *Annual Report – United States Securities and Exchange Commission Form 10-K.* Retrieved on 12.06.2020 from http://d18rn0p25nwr6d.cloudfront.net/CIK-0000104169/af5415d9-0e07-4ba1-a6cc-bb3058a7f4e8.pdf

Wing, C.; Simon, K. and Bello-Gomez, R. A. (2018). Designing Difference in Difference Studies: Best Practices for Public Health Policy Research. *Annual Review of Public Health 39* pp. 453-469

Zhang, S.; van Duijn, M. and van der Vlist, A. J. (2019). The external effects of inner-city shopping centers: Evidence from the Netherlands. *Journal of Regional Science Accepted Articles*

Appendix

Appendix – 1 Geocoding of the Price Paid Dataset

Due to the high number of observations (> 20 million) in the dataset, geocoding of the whole dataset is not possible. Therefore, several steps were done to reduce the data needing geocoding: First, only observations around the period of investigation are kept (2008 until 2016), thereby reducing the dataset to 7.106.123 observations. Second, the dataset is merged with the National Statistics Postcode Lookup dataset which provides geocoded location data for all postcodes in the UK (NSPL, 2011). The match fails for 317.124 (~4,5 percent) transactions. However, since there is no reason to assume that these missing values are in any way correlated with the variables included in the analysis, this should not have any effects on the results. Third, only transactions not further than 4 kilometres from the opening of a Morrisons store are kept and matched with the closest store, based on the postcode-location. This reduces the sample size to 318.983 observations. Fourth, all transactions which took place between two years before until two years after the opening of the respective store are identified. By doing so, the sample size is further reduced to the number of observations of 120.838. Lastly, these observations are geocoded with ArcMap. The number of errors and not perfect matches is very low with less than 1 percent. The lower number of 92,217 observations results from the exclusion of stores in Wales and Scotland after adding auxiliary neighborhood variables.

Appendix – 2 Summary table by the announcement date

Table 6 - Summary Statistics by Date of Transaction, Treatment Groups and Control Group

All transactions **before and after** the plausible **announcement**

	Pooled Sample (N=92,217)		Treatment Group 1000 meter from store (N=1,358)		Treatment Group 1000 to 2000 meter from store (N=2,916)		Control Group further than 2000 meter from store (N=87,943)	
	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Price in Pound	172,170	94,102.27	171,999	87,442.74	169,960	76,086.79	172,245	94,739.41
Population Density	4,636.84	2,814.324	4,749.395	3,049.066	4,729.496	2,627.855	4,632.03	2,816.468
Crime Deprivation Score	0.205	0.747	0.226	0.822	0.23	0.866	0.204	0.741
Education Deprivation Score	22.695	17.351	25.785	16.879	21.097	15.741	22.701	17.403
Environment Deprivation Score	25.237	17.179	26.904	18.92	24.688	18.182	25.229	17.115
Supermarket size in square meter	4,917.155	1,855.847	4,804.713	1,862.271	5,782.647	1,576.75	4,890.194	1,857.383
Time to next store (by foot, minutes, 2008)	7.372	5.556	7.298	3.401	6.954	3.644	7.387	5.634
Detached Houses	0.15	0.357	0.127	0.334	0.194	0.396	0.149	0.356
Flats and Apartments	0.187	0.39	0.143	0.35	0.224	0.417	0.187	0.39
Semi-Detached Houses	0.314	0.464	0.37	0.483	0.277	0.448	0.314	0.464
Terraced Houses	0.349	0.477	0.36	0.48	0.304	0.46	0.35	0.477
Newly built	0.085	0.28	0.049	0.215	0.114	0.318	0.085	0.279
Freehold	0.745	0.436	0.839	0.368	0.766	0.423	0.743	0.437
Leasehold	0.255	0.436	0.161	0.368	0.234	0.423	0.257	0.437

Only transactions taking place **before** the plausible **announcement** (PostAnnouncement=0)

	Pooled Sample (N=21,515)		Treatment Group 1000 meter from store (N=295)		Treatment Group 1000 to 2000 meter from store (N=582)		Control Group further than 2000 meter from store (N=20,638)	
	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Price in Pound	167,458	89,377.02	169,354	89135.89	159,027	75279.21	167,669	89,737.91
Population Density	4,712.982	2,937.176	4,916.864	3,317.209	4,596.804	2,778.343	4,713.344	2,935.739
Crime Deprivation Score	0.229	0.756	0.265	0.816	0.149	0.822	0.231	0.753
Education Deprivation Score	23.22	17.574	27.448	17.096	20.498	16.448	23.236	17.599
Environment Deprivation Score	25.755	17.62	28.509	19.181	24.943	18.951	25.739	17.555
Supermarket size in square meter	4,858.554	1,847.49	4,769.831	1,780.183	5,704.983	1,657.308	4,835.953	1,847.963
Time to next store (by foot, minutes, 2008)	7.33	4.253	7.018	3.224	7.294	2.881	7.336	4.298
Detached Houses	0.146	0.353	0.129	0.336	0.21	0.407	0.144	0.351
Flats and Apartments	0.185	0.388	0.146	0.353	0.175	0.381	0.186	0.389
Semi-Detached Houses	0.312	0.463	0.376	0.485	0.285	0.452	0.311	0.463
Terraced Houses	0.358	0.479	0.349	0.478	0.33	0.471	0.359	0.48
Newly built	0.1	0.299	0.051	0.22	0.079	0.27	0.101	0.301
Freehold	0.745	0.436	0.837	0.37	0.823	0.382	0.741	0.438
Leasehold	.0255	0.436	0.163	0.37	0.177	0.382	0.259	0.438

Only transactions taking place **after** the plausible **announcement** (PostAnnouncement=1)

	Pooled Sample (N=70,702)		Treatment Group 1000 meter from store (N=1,063)		Treatment Group 1000 to 2000 meter from store (N=2,334)		Control Group further than 2000 meter from store (N=67,305)	
	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev	Mean	St. Dev
Price in Pound	173,603	95448.26	172,732	86,995.31	172,687	76,058.31	173,649	96,178
Population Density	4,613.67	2,775.467	4,702.919	2,970.358	4,762.584	2,588.529	4,607.096	2,778.416
Crime Deprivation Score	0.198	0.744	0.215	0.824	0.251	0.876	0.196	0.737
Education Deprivation Score	22.536	17.28	25.324	16.798	21.247	15.559	22.537	17.339
Environment Deprivation Score	25.079	17.039	26.458	18.832	24.625	17.989	25.073	16.975
Supermarket size in square meter	4,934.988	1,858.029	4,814.393	1,885.116	5,802.014	1,555.778	4,906.826	1,859.959
Time to next store (by foot, minutes, 2008)	7.385	5.896	7.375	3.446	6.869	3.806	7.403	5.984
Detached Houses	0.151	0.358	0.127	0.333	0.191	0.393	0.15	0.357
Flats and Apartments	0.188	0.391	0.142	0.349	0.237	0.425	0.187	0.39
Semi-Detached Houses	0.315	0.464	0.368	0.482	0.275	0.447	0.315	0.465
Terraced Houses	0.346	0.476	0.363	0.481	0.297	0.457	0.347	0.476
Newly built	0.081	0.273	0.048	0.214	0.123	0.328	0.08	0.272
Freehold	0.745	0.436	0.839	0.368	0.752	0.432	0.743	0.437
Leasehold	0.255	0.436	0.161	0.368	0.248	0.432	0.257	0.437

Appendix – 3 Full Regressions

Table 7 - Full Regression showing all auxiliary variables

	(1a)	(1)	(2)
	Pooled Model without Difference-in-Difference Variables	Pooled Model; Post Variable indicating the Opening	Pooled Model; Post Variable indicating the Announcement
Flat (Reference Category: Detached)	-0.764***	-0.764***	-0.764***
	(-45.94)	(-45.95)	(-45.93)
Semi-Detached (Reference Category: Detached)	-0.310***	-0.310***	-0.310***
	(-48.13)	(-48.14)	(-48.13)
Terraced (Reference Category: Detached)	-0.478***	-0.478***	-0.478***
	(-60.66)	(-60.67)	(-60.65)
Newly built	0.234***	0.234***	0.234***
	(16.27)	(16.30)	(16.34)
Leasehold	-0.0736***	-0.0736***	-0.0736***
	(-4.85)	(-4.85)	(-4.85)
Population Density	-0.0000185***	-0.0000185***	-0.0000185***
	(-4.69)	(-4.69)	(-4.70)
Population Density [squared]	4.32e-10	4.32e-10	4.32e-10
	(1.40)	(1.40)	(1.41)
Crime Deprivation	0.0200***	0.0200***	0.0199***
	(2.60)	(2.60)	(2.59)
Crime Deprivation [squared]	-0.00280	-0.00282	-0.00289
	(-0.52)	(-0.53)	(-0.54)
Education Deprivation	-0.0182***	-0.0182***	-0.0182***
	(-22.19)	(-22.19)	(-22.24)
Education Deprivation [squared]	0.000145***	0.000145***	0.000145***
	(13.53)	(13.54)	(13.57)
Environment Deprivation	0.00181*	0.00181*	0.00181*
	(1.85)	(1.85)	(1.85)
Environment Deprivation [squared]	-0.0000577***	-0.0000577***	-0.0000577***
	(-4.46)	(-4.46)	(-4.45)
PostOpening		-0.0000478	
		(-0.01)	
PostAnnouncement			-0.00681
			(-0.74)
Treatment 0m-1000m		0.00212	0.0124
		(0.12)	(0.61)
Treatment 1000m-2000m		-0.00368	-0.0389*
		(-0.17)	(-1.92)
PostOpening * Treatment 0m-1000m		-0.000276	
		(-0.02)	
PostOpening * Treatment 1000m-2000m		0.00786	
		(0.50)	
PostAnnouncement * Treatment 0m-1000m			-0.0133
			(-0.81)
PostAnnouncement * Treatment 1000m-2000m			0.0497**
			(2.51)
Constant	12.71***	12.71***	12.71***
	(664.87)	(648.78)	(626.25)
Quarter-by-Year-by-Store Fixed Effects	Yes	Yes	Yes
Observations	92,217	92,217	92,217
Adjusted R^2	0.535	0.535	0.535

Note: Dependent Variable is the natural log of the property transaction price. All models include quarter-by-year-by-store fixed effects and the standard errors are clustered by each LSOA. *t* statistics in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Where:

- Flat takes the value of 1 if the sold property is a flat, 0 otherwise
- Terraced takes the value of 1 if the sold property is a terraced house, 0 otherwise
- SemiDetached takes the value of 1 if the sold property is semi-detached, 0 otherwise

- Newly built takes the value of 1 if the property was newly built and the first owner is moving in
- Leasehold takes the value of 1 if the buyer only buys the right to occupy the land for a given length of time (instead of full ownership)
- Population Density is the value of residents per square kilometer
- Crime Deprivation is a score showing the crime rate in the neighborhood where higher values correspond to less crime. The values should only be interpreted to compare neighborhoods (Communities & Local Government, 2011).
- Education Deprivation is a score showing the quality of education where higher values correspond to worse Education. The values should only be interpreted to compare neighborhoods (Communities & Local Government, 2011).
- Environment Deprivation is a score showing the level of environmental degradation where higher values correspond to a "better" environment. The values should only be interpreted to compare neighborhoods (Communities & Local Government, 2011).

Appendix – 4 Additional Regressions

To assess whether coefficients are significantly different from each other, the variables of interest are multiplied with dummies indicating the various sub-samples: For example, for Model (3) and (4) which divide the sample by the size of the new store, Model (11) introduces a dummy indicating whether a store is large (>=5,000 sqm). The *PostAnnouncement* * *Treatment* variables and *Treatment* variables are interacted with this dummy. Afterwards, tests of equality of the coefficients are carried out.

Table 8 - Regressions used for comparing coefficients between Sub-Samples

	(11) Comparison of Big and Small Supermarkets	(12) Comparison of Best and Worst Access	(13) Comparison between Property Types
Flat	-0.764***	-0.764***	-0.768***
	(-45.94)	(-45.96)	(-45.95)
Semi-Detached	-0.310***	-0.310***	-0.312***
	(-48.15)	(-48.13)	(-47.20)
Terraced	-0.478***	-0.478***	-0.480***
	(-60.69)	(-60.57)	(-60.03)
PostAnnouncement	-0.00694	-0.00690	-0.00656
	(-0.75)	(-0.75)	(-0.71)
Treatment0m-1000m	0.00105	-0.0452*	0.0401
	(0.04)	(-1.80)	(0.94)
Treatment1000m-2000m	-0.0222	-0.0829***	-0.0718**
	(-0.86)	(-2.89)	(-2.14)
PostAnnouncement * Treatment0m-1000m	0.00518	0.0266	-0.0434
	(0.23)	(1.14)	(-0.94)
PostAnnouncement * Treatment1000m-2000m	0.0347	0.0511**	0.0247
	(1.53)	(2.09)	(0.75)
Treatment0-1000m * BigStore	0.0253		
	(0.62)		
Treatment1000m-2000m * BigStore	-0.0275		
	(-0.73)		
PostAnnouncement * Treatment0-1000m * BigStore	-0.0404		
	(-1.24)		
PostAnnouncement * Treatment1000m-2000m * BigStore	0.0247		

	(0.69)		
CloseSupermarket		-0.00853	
		(-1.18)	
Treatment0-1000m * CloseSupermarket		0.112***	
		(2.96)	
Treatment1000m-2000m * CloseSupermarket		0.0934**	
		(2.47)	
PostAnnouncement * Treatment0-1000m * CloseSupermarket		-0.0743**	
		(-2.31)	
PostAnnouncement * Treatment1000-2000m * CloseSupermarket		-0.0132	
		(-0.40)	
Treatment0-1000m * Flat			-0.0360
			(-0.48)
Treatment0-1000m * Semi_Detached			-0.0141
			(-0.28)
Treatment0-1000m * Terraced			-0.0486
			(-1.03)
Treatment1000m-2000m * Flat			0.0752
			(1.62)
Treatment1000m-2000m * Semi_Detached			0.0297
			(0.77)
Treatment1000m-2000m * Terraced			0.0325
			(0.93)
PostAnnouncement * Treatment0m-1000m * Flat			-0.0483
			(-0.67)
PostAnnouncement * Treatment0-1000m * Semi_Detached			0.0421
			(0.81)
PostAnnouncement * Treatment0m-1000m * Terraced			0.0599
			(1.18)
PostAnnouncement * Treatment1000m-2000m * Flat			0.0582
			(1.23)
PostAnnouncement * Treatment1000m-2000m * Semi_Detached			0.00880
			(0.20)
PostAnnouncement * Treatment1000m-2000m * Terraced			0.0207
			(0.52)
Quarter-by-Year-by-Store Fixed Effects	Yes	Yes	Yes
Property Characteristics	Yes	Yes	Yes
Neighborhood Characteristics	Yes	Yes	Yes
Observations	92,217	92,217	92,217
Adjusted R^2	0.535	0.535	0.535

Note: Dependent Variable is the natural log of the property transaction price. All models include quarter-by-year-by-store fixed effects and the standard errors are clustered by each LSOA. *t* statistics in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In Models (11) – (13):

- BigStore takes the value of 1 if the store is larger than or equal to 5,000 square meters and otherwise a value of 0
- CloseStore takes the value of 1 if before Morrisons opened it took less than 7,5 minutes to walk to a store (Best 50 percent of neighborhoods in terms of food access) and 0 if it took more time (Worst 50 percentf of neighborhoods in terms of food access)
- Flat takes the value of 1 if the sold property is a flat, 0 otherwise
- Terraced takes the value of 1 if the sold property is a terraced house, 0 otherwise
- SemiDetached takes the value of 1 if the sold property is semi-detached, 0 otherwise

Testing for Equality of Coefficients

Model (11)

Since none of the interaction terms with *BigStore* are significant, there are no significant differences.

Model (12)

Several interaction terms with *CloseStore* are significant, indicating significant differences between the impact in areas with good food access to areas with bad food access before the opening. Noteworthy is that the coefficient of *PostAnnouncement * Treatment0m-1,000m * CloseStore* indicates significantly lower prices for close properties in areas with good food access before the opening. Property prices are lower by 4.658 percent [=(exp(0.0266-0.0743)-1)*100 percent] after the opening compared to the control area and areas with bad food access.

Model (13)

Whether the impact on property prices after the store opens is significantly different from the impact on the reference category of Detached houses can easily be read of by the significance of the *PostAnnouncement * Treatment1,000m-2,000m* terms multiplied by each of the property dummies. However, further tests are necessary to see whether these interaction terms are significantly different among each other. Table 9 shows for each coefficient whether the Null Hypothesis (that $\beta_i = \beta_j$) can be rejected. For an alpha of 0.05, the Null Hypothesis is rejected if $p<0.05$ or if the F-statistic is larger than the critical F-value $F(1, 35)= 4{,}12$. None of the tests show a strong significant difference between the coefficients. The impact of flats is weakly significant different from the impact of Semi-Detached houses. In addition, Table 9 shows that this impact is also significantly different from the impact of Detached houses.

*Table 9 - Test of equality of the Coefficients for the PostAnnouncement * Treatment1,000m-2,000m terms*

	Post_Announcement * Treatment1000m-2000m * Flat	Post_Announcement * Treatment1000m-2000m * Semi_Detached	Post_Announcement * Treatment1000m-2000m * Terraced
Post_Announcement * Treatment1000m-2000m * Flat		F=1.16 p=0.2814	F=0.91 p=0.3402
Post_Announcement * Treatment1000m-2000m * Semi_Detached			F=0.15 p=0.7030

Appendix 5 - Parallel trends before opening or announcement

As previously discussed, the most important assumption in a difference-in-differences framework to hold is the common trends for the treatment and control groups before the treatment took place. To understand whether the trends are parallel before the treatment, price movements are analyzed more closely. Due to the geocoding limitations (process described in Appendix – 1 Geocoding of the Price Paid Dataset), only a timeline of two years before to two years after the opening of Morrisons can be analyzed. While this may complicate conclusions about the similarity of the trend, especially before the store was announced, it still gives hints on the validity of the previously found results.

As described by Daams et al. (2019), a graphical analysis of regression residuals is performed. The specifications of each sub-sample with results of interest are re-estimated while leaving out the

difference-in-differences parameters (*Post, Treatment1,000/2,000* and *Post*Treatment1,000/2,000*). The mean of the residuals is calculated by quarter and distance to the opening. Figure 6 shows these average residuals with Quarters to and since the supermarket opening on the x-axis and mean of the residuals on the y-axis. Since the dependent variable is in log-form, the residuals are also in log-form and can approximately be interpreted as price levels in percentages.

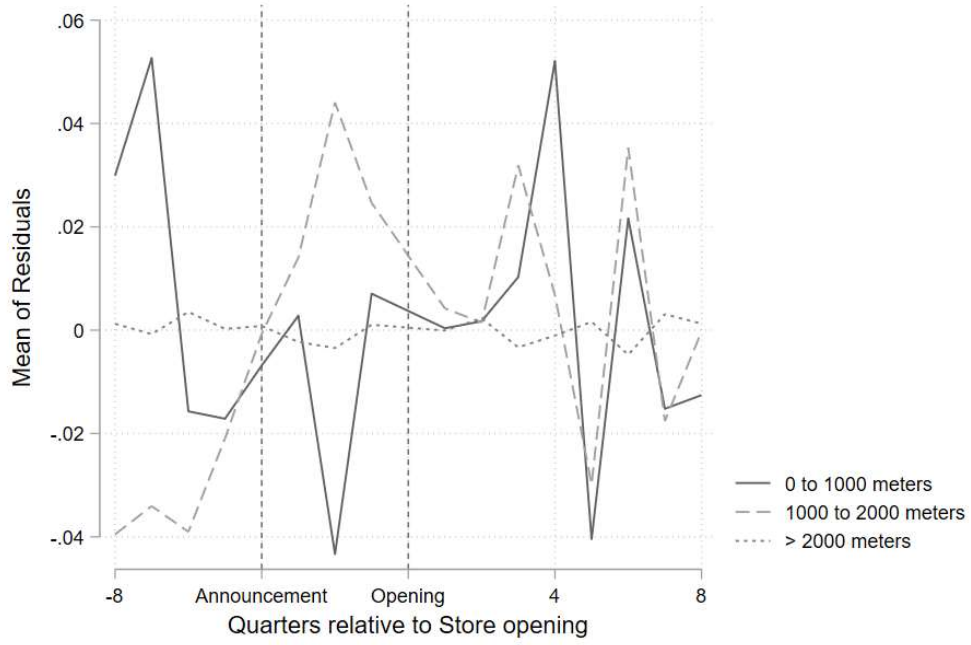

Figure 6 - Residual plot of Pooled Regression [Model (1) and (2) without DiD terms]

Since most of the transactions took place further than 2,000 meters from the supermarket opening (approximately 95 percent) it is expected that this line stays close to 0 across all quarters. The line for properties sold in 0 to 1,000 meters from the opening is showing strong volatility. Several positive and negative outliers occur during the observed period. This is in line with the regression findings that no clear trend can be identified. Finally, the line for 1,000 to 2,000 meters from the new store seems to pick up an increase in house prices even before the announcement date. In the first three quarters (-8, -7, -6), the line runs relatively parallel to the control area line at about 4-5 percent lower prices (also confirmed by the coefficient of *Treatment1,000m-2,000m* in model (2)). Shortly before the announcement, the price level increases and stays around the control area line, however, exhibiting strong volatility. While the assumption of parallel trends holds for the first three quarters, a much larger time horizon would be necessary to conclusively test the fulfillment of the assumption. This was, however, hindered by geocoding restrictions (see Appendix – 1 Geocoding of the Price Paid Dataset and Further Research).

For selected sub-samples, the same analysis is undertaken while focusing on the previously found significant effects. Figure 7 shows the graph for the subsample of large stores (Model 4). For the treatment area of 1,000 to 2,000 meters before the announcement, the property prices are between 3 to

6 percent lower than in the control area. Afterwards, the prices fluctuate around the control area with a few upper outliers. It is difficult to say whether the trend was similar before the announcement took place as the prices are already increasing two quarters before the announcement. A possible explanation may be that large stores also require longer development times and, therefore, the announcement took place even earlier.

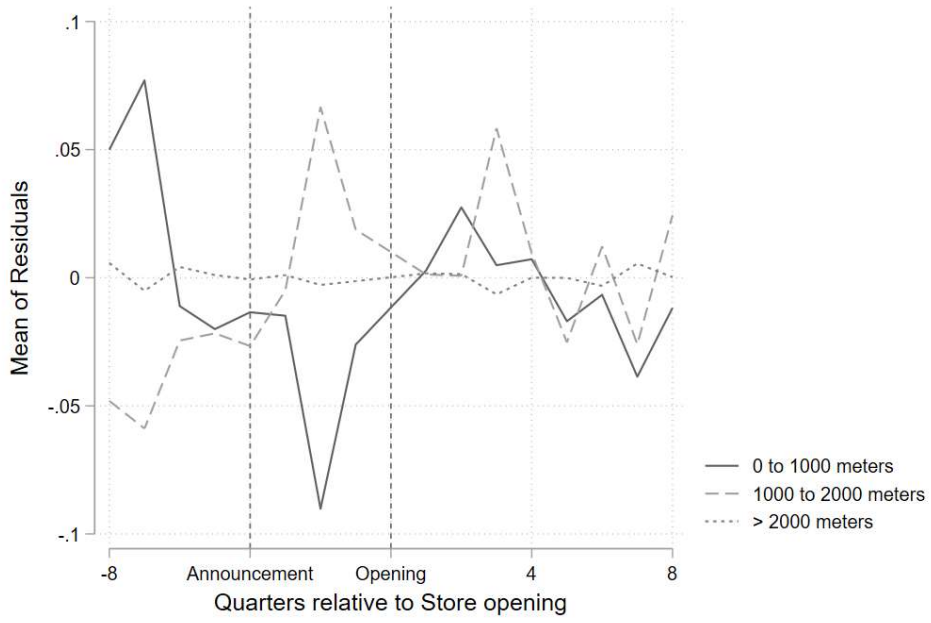

Figure 7 - Residual plot for sub-sample of large stores [Model (4) without DiD terms]

Figure 8 presents the residuals of the neighborhoods with the best food access prior to the opening [model (6)] and shows two opposing trends: First, the line for 0 to 1,000 meters shows higher prices before the supermarket was announced. The prices start to decrease even before the announcement. Second, the line for properties in 1,000 to 2,000 meters displays lower prices before the store is announced. Again, even before the announcement, the prices start to pick up and are, on average, greater than both other groups.

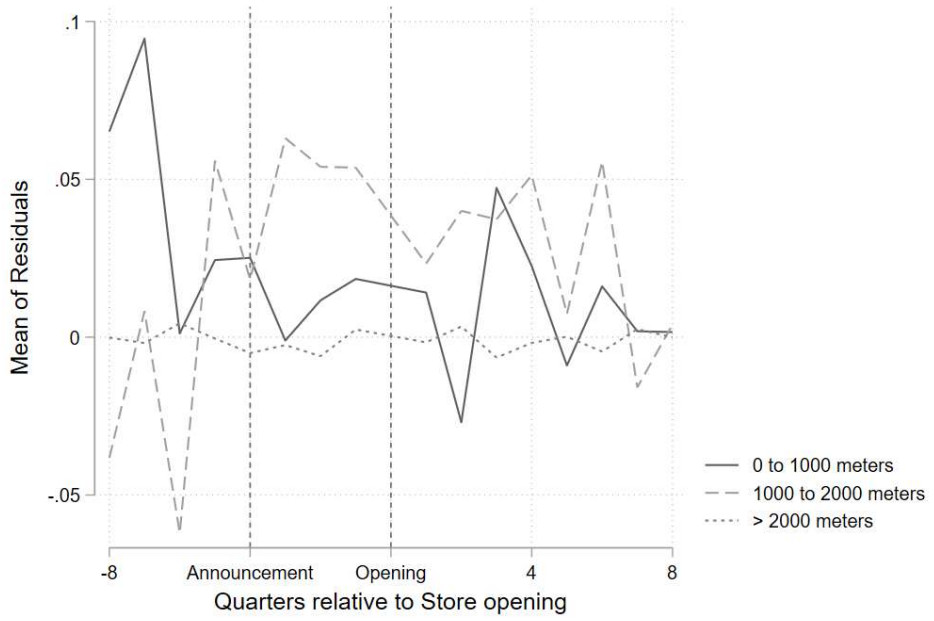

Figure 8 - Residual plot for sub-sample with best food access before the opening of Morrisons [Model (6) without DiD terms]

Lastly, Figure 9 shows the graph for the subsample of only flats and apartments (model 10). As already noted, when describing the regression results, in an area of 1,000 to 2,000 meters the impact on flats is by far the most pronounced. The graph underlines, however, that the impact might be even earlier than assumed during the analysis. Besides, the effect decreases with time; at the end of the observed timeline, the difference to the control area is nonexistent. Furthermore, the residuals are far more volatile than for all other sub-samples.

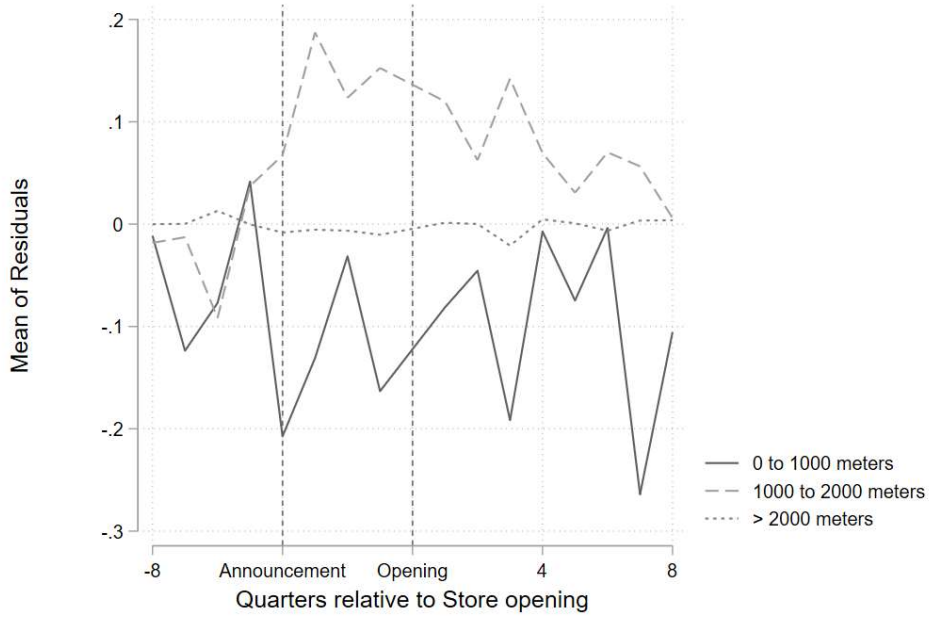

Figure 9 - Residual Plot for the sub-sample consisting only of flats and apartments [Model (10) without DiD terms]

The graphs underline that the analysis should be done with larger time horizons to get a better understanding of the timeline of effects and to prove the assumption of parallel trends before the announcement and/ or opening.[4] In practice, the costs of geocoding prevented any increase in observation size (Appendix – 1 Geocoding of the Price Paid Dataset).

[4] Slade (2017) suggests that the time frame to be analyzed should be much wider as negotiation may already start up to 4 years before a store opening. Further, planning restrictions in England are substantially stricter than in the US implying even longer periods from announcement to actual opening.