The urban economics of retail

Coen N. Teulings[#], Ioulia V. Ossokina [##] and Jan Svitak [###][*]

[#]University of Cambridge, University of Amsterdam and Tinbergen Institute

[##]Eindhoven University of Technology and CPB Netherlands Bureau for Economic Policy Analysis

[###]The Netherlands Authority for Consumers and Markets

12 August 2016

Abstract

This paper studies the land use in urban shopping areas and the competition between residential and retail land in a city. We demonstrate that shopping areas have a monocentric spatial structure with one pronounced centre where the rents are the highest, and a negative rent gradient. At the edge of a shopping area retail land use competes with residential land use, leading to a clustering of vacancies and to mixed land use. These predictions are derived in a simple theoretical model and tested on unique data on the location and characteristics of all retail and non-retail properties within 300 largest shopping areas in the Netherlands in 2004-2014. With every 100 meter distance from the centre of a shopping area rents fall with up to 18 percent while vacancies and mixed land use grow with a factor 1.2 respectively 0.6. Our data cover the Great Recession, the subsequent decline of private consumption and the rise in internet shopping. During the Great Recession retail rents declined and vacancies increased simultaneously as predicted by our model. Also transformations to other land use took place, mostly at the edge of the shopping areas. Our model suggests that in some locations, even more transformations are profitable.

JEL Codes: L81, R13, R3, R4

Keywords: land use, retailers, rent gradient, vacancy, transformation

1 Introduction

This paper exploits four unique datasets to study the land use in urban shopping areas[1] and the competition between residential and retail land in a city. Traditionally, urban economics has focused on the land market for housing and - more recently - businesses (see for a recent application Ahlfeldt et al., 2016 and the references therin). Next to living and working, an important part of urban space is occupied by retail.[2] Yet to the best of our knowledge, there are no empirical studies of retail land use. In this paper we show empirically that the spatial structure of a shopping area resembles that of a monocentric city. This holds for shopping areas in downtowns as well as shopping streets and districts. They all tend to have one pronounced centre where the level of the rents is the highest. Rents fall with the distance to this centre. We show theoretically that this spatial structure follows from a simple model where consumers incur transportation costs to move from one shop to another. We add to this model competition between retail and residential land use to derive hypotheses on the spatial distribution of vacancies and mixed land use within a shopping area. The model also predicts how land use in a shopping area reacts to a negative demand shock such as the Great Recession. We test these hypotheses using our rich dataset containing data on the location and characteristics of all retail and non-retail properties within 300 largest shopping areas in the Netherlands and a sample of retail rent transactions in 2004-2014, a period including the Great Recession.

In our model, shopping areas are located in a city. Their location is exogenously given and they are surrounded by residential land. Retailers decide in which shopping area to locate. They take the retail land rent and the number of consumers in a shopping area as given. Consumers travel to the centre of a shopping area and randomly walk from there to shops located around. Profitability of a shop depends on the number of consumers who visit it, so profits and rents are the highest in the centre of a shopping area and decline with distance. Land rents clear the market at each retail location.

Consumers decide to which shopping area to go and how long to stay there, depending on the attractivity of the place. Therefore, the more attractive shopping areas will, ceteris

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[1] Our term 'shopping area' refers to various retail concentrations including: a downtown, a shopping street or district, a mall, etc.

[2] In Dutch urban municipalities 60% of the urban land is occupied by housing, 30% by businesses and 10% by retail and culture.

paribus, have higher rent levels. Conditional on having arrived, the probability that a consumer visits a shop on a certain distance from the centre may differ by shopping area too, leading to a flatter or steeper rent gradient. Areas that induce consumers to stay longer, for instance due to the presence of attractions such as historical monuments or due to zero parking costs, will have a flatter land gradient. Areas with a one-dimensional geometry (shopping streets) will also exhibit a flatter land gradient.

At the boundary of a shopping area retail land use competes with an alternative land use, often residential. If the size of a shopping area is determined endogenously, then the area will expand until, at the boundary, the retail land rent equals the residential land rent. This no-arbitrage condition ensures that land is attributed to the use with the highest bid-rent. A negative shock in demand for retail products results in a downward shift of the retail bid-rent curve, and, in the long run, in a contraction of the shopping area due to the transformation of retail properties at the edge into residential use. In the short run, however, the size of the shopping area is likely to be given. Then a negative demand shock may lead to a negative bid-rent at the boundary and thus vacancy there. Hence, our model predicts that the vacancy rate and the share of non-retail land use should rise with the distance to the centre of a shopping area. Furthermore, a negative shock in demand should lead to (i) a simultaneous rise in vacancies and fall in rents; (ii) transformation of land from retail to other use, more so at the edge.

We apply this theoretical framework to a selection of some 300 largest shopping areas in the Netherlands that contain 40% of all the retail in the country, and show that our monocentric land use model does a good job in describing their spatial structure. We determine the centre of each shopping area empirically as the spot with the highest density of shops. We show that shopping areas tend to have a pronounced centre, with shop densities decreasing with one third with every 100 meter extra distance from this centre. We find a strong and robust distance effect in all our other variables of interest: rents, vacancies and the share of non-retail land use. Rents decrease with up to 18%, vacancies increase with a factor 1.2 and non-retail land use increases with a factor 0.6 with every 100 meter extra distance from the centre of a shopping area. The distance effect becomes flatter near the edge. In shopping streets, areas with zero parking costs and areas with a large supply of historical sights the rent gradient is up to two times smaller. These results are in line with our theoretical predictions and robust to various tests we apply.

The Great Recession led to a prolongued negative demand shock in the Netherlands: consumption of goods and retail sales dropped with 10% in the period 2008-2014. We show that the retail land market reacted as predicted by our theoretical model. Retail rents declined with 20%, and simultaneously, vacancies increased with a factor 1.6. Retail properties were transformed to other land use, more so near the edge of the shopping areas.

This paper is connected to several strands of literature. First, there is a large literature studying the urban structure and the interaction between different land uses within a city (see for a recent overview Duranton and Puga, 2014). Many papers use a monocentric city framework in which residential neighbourhoods surround the central business district. A recent example is Combes, Duranton and Gobillon (2016) who calculate residential land price gradients for different French cities. Lucas and Rossi-Hansberg (2002) develop a theoretical model of a city where the equilibrium patterns of working and housing can vary. Ahlfeldt et al. (2016) build a structural model of internal city structure with many discrete locations that can be used for both, living and working. We are not aware of studies that focus on the retail land use. In this paper we apply a monocentric model traditionally used to describe residential land rents to explain the distribution of rents and vacancies within shopping areas. Furthermore, we provide new insights into the interaction between the residential and the retail land uses.

Second, our paper is related to studies that analyse the role of distance for retail location choice. Ushev, Sloev and Thisse (2015) show theoretically that despite a further away location, a suburban shopping mall can win competition from downtown incumbent retailers if the shopping mall developer better internalizes the agglomeration externalities shops exert on one another. Gould et al. (2005) find empirically that shops are ready to pay higher rents for locations on a short distance from an anchor store, to profit from the higher consumer flows it generates. Liu, Rosenthal and Strange (2016) show that in tall buildings retail usually only occupies the ground floor. Transportation costs the consumers have to incur to get to higher floors turn to be prohibitive to locate there. We illustrate that walking distance to the centre of the shopping area matters for retail profits and shop rents.

Third, there is a growing literature on the impact of various economic trends and policies on the retail market. Foster et al. (2006) show that high productivity growth in the American retail sector in 1990's is largely accounted for by the entrance of large more productive chain stores and exit of smaller less productive retailers. Coilion et al. (2015)

show that higher unemployment generally leads to reallocation of consumption expenditures to cheaper stores. Cheshire, Hilber and Kaplanis (2011) find empirically that urban planning policies supporting downtown shopping areas at the cost of suburbs involve welfare costs in terms of lost output in retail and a smaller supply of shops. Koster et al. (2016) study the positive externalities arising from clustering of shops and suggest that policies stimulating this clustering may be welfare-improving. We use our model to predict how rents, vacancies and land use in a shopping area react to the general decline in demand and find support for these predictions in the data.

Finally, there are a few studies analysing the determinants of retail real estate development. Clapp et al. (2015) study the determinants of expansion and contraction of shopping centres and provide an extensive literature review. These studies do not explicitly model the land market, nor do they account for competition for land between different uses, while our paper does.

Our research results are interesting for two reasons. First, we provide new insights into the working of the retail real estate market. Retail occupies an important place in urban space and is an important segment of the economy: In 2012 it accounted for some 10% of the jobs and around 20% of household expenditures; 20% of trips made had shopping as a motive.

Second, our paper contributes to furthering the understanding of how cities operate and grow. Historically many cities have developed around a shopping centre. A widespread adoption of the car led to decentralisation of living, working, but also retail. In the US this resulted in the arisal of 'donut' cities, where empty downtowns hosting vacant shops, are surrounded by residential neighbourhoods.[3] In Europe the policy makers and the society are concerned lest a similar development should take place. In this paper we illustrate how the real estate market in a shopping area reacts to a drop in consumption.

The structure of the paper is as follows. Section 2 presents some stylized facts that inspired our model. Section 3 introduces the theoretical model, derives empirical predictions and discusses how they will be tested. Section 4 describes the data. Section 5 reports the baseline estimation results for the spatial structure of shopping areas and tests their

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[3]Fogelson (2005) observes for the United States that "the decentralization of the department stores is one of the main reasons that the central business district, once the mecca for shoppers, does less than 5 percent of the retail trade of metropolitan areas everywhere but in New York, New Orleans, and San Francisco".

robustness. Section 6 deals with the tyme dynamics and discusses the policy implications. Section 7 concludes.

2 Stylized facts

In this paper we document that shopping areas in the Netherlands have a monocentric spatial structure. There is a clearly defined centre, where shop density is the highest and the rents are the highest. Both density and rents decrease with the distance to this centre. Figure 1 below shows this density pattern for 9 shopping areas of different size. Shop density in a location is defined as a weighted average of the number of shops within three radiuses from the location: 50m, 50-100m and 100-250m: $0.45\text{shops}_{<50m} + 0.35\text{shops}_{50-100m} + 0.2\text{shops}_{100-250m}$. The choice for the weighted average of densities on different distances has practical reasons, namely avoiding degenerate solutions. Using the smallest radius of 50 meter could yield unreasonably high density for a tall building standing on the edge of a shopping area. Using the large radius of 250 meter would result in the same density for all shops located in a small shopping street. The monocentric density pattern depicted in Figure 1 holds for other larger shopping areas too: a simple fixed effect OLS of densities on distance suggests a decrease in density of 34% with every 100 meter more distance from the centre.

Figure 2 presents a semi-parametric estimate of the relationship between the retail rents and distance to the centre of the shopping area defined as the spot with the highest density. The figure documents that retail rents steadily decrease with the distance to the centre.

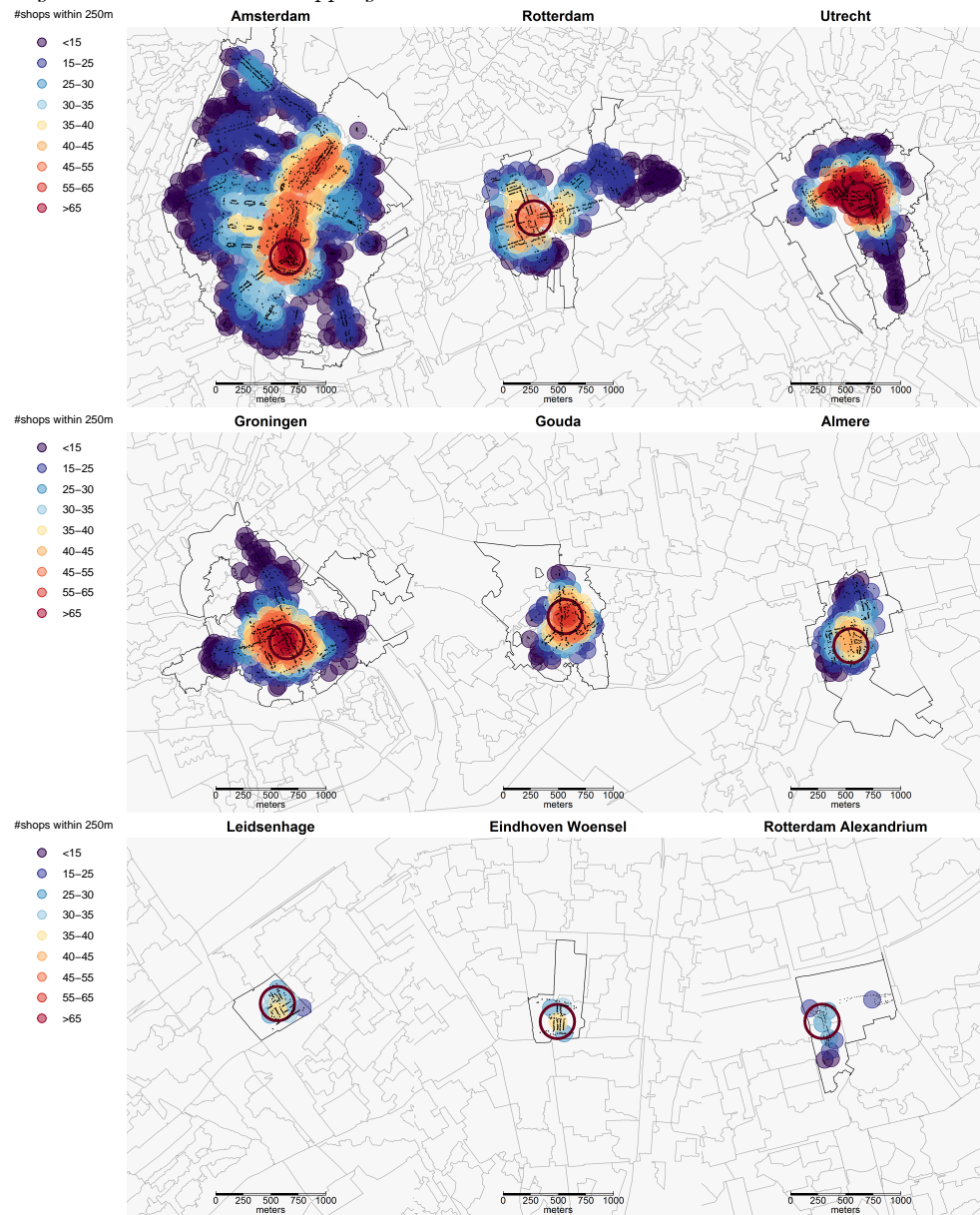*Figure 1. Densities in shopping areas.*

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Figure 2. Non-parametric estimates of the rent gradient

Distance decay in retail rents (index, center=1)

Distance to the center of shopping area, m

3   General framework

In this section we develop a simple theoretical model that results in the spatial structure of a shopping area described above, and study its implications.

3.1   Model

Our theoretical model rests on the following set of assumptions:

- There are $s \in S$ shopping area's, each located in a two-dimensional residential space and surrounded by residential land use. The number and location of the shopping areas is exogenously given. Shopping area s hosts shops $r_s \in R_s$, which are identified by their geographical location. The land A_s taken by each shopping area is determined endogenously.

- Land is owned by absentee landlords who extract the profits from tenants (retailers or residents) in the form of land rents. Land is divided in lots of a given size. Each lot is equally suitable for residential and retail use and is assigned to the highest bidder.

- There are N consumers. Each consumer chooses to which shopping area s she wants to go and how much time t_s she wants to spend there. The choice of s is exogenous to our model and results in N_s visitors to shopping area s. Each consumer goes to one and only one shopping area, so $\sum_s N_s = N$. The length of the stay t_s is also exogenous and varies with the characteristics of the shopping area. For instance, shopping areas with zero

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parking costs or with tourist attractions likely induce a longer stay. Each consumer buys on average one product per unit of time, so t_s products per visit to a shopping area.

- All consumers going to s begin their shopping trip in the same arrival point located within the shopping area s; we call it the centre (think of a transport hub: metro station and/or parking). From there they walk to shops. We will show below that the assumption of a single arrival point can be relaxed. The probability that a consumer makes a purchase in shop r_s located at distance d from the centre is described by a concave density function $\varphi_s(d)$. We assume that φ_s has a finite support $D(t_s)$ and that $\frac{\partial \varphi_s}{\partial d} < 0$. The first condition says that there exists a maximal distance D which a consumer is willing to walk: $\varphi_s > 0$ for $d < D$ and $\varphi_s = 0$ for $d \geq D$. The second condition states that the probability of a purchase is the smaller the further a shop is located from the centre. This holds because the number of shops located within distance d grows with d. Finally, φ_s may vary across types of shopping areas. For instance, we expect $\varphi_s(d)$ ceteris paribus to be higher for one-dimensional shopping areas (streets), as they have fewer shops within distance d.

Using these assumptions, for each shop r_s we can write the expected demand as

$$D_{r_s} = N_s t_s \varphi_s(d). \tag{1}$$

The demand function is concave, rises with t_s and falls with d. The profits of shop r_s located at distance d from the hub equals:

$$\pi = D_{r_s} - C - R(r_s) \tag{2}$$

where $R(r_s)$ is the retail rent, C are fixed costs of running a shop and both the price of the good and the land lot taken by shop r_s have been normalised to one. Using the zero-profit condition we can rewrite the bid-rent as:

$$R(r_s) = D_{r_s} - C \tag{3}$$

The rent rises with t_s and falls with d. This leads to Proposition 1.

Proposition 1. *Shopping areas have a monocentric structure with a single centre where the rents are the highest. The rent gradient is negative: rents decrease with the distance to the centre. The rent gradient is flatter for shopping areas with one-dimensional geometry*

(streets) and for areas stimulating a longer stay (e.g. those having zero parking costs, tourist attractions).

Our assumption of a single arrival point was made for the ease of presentation, but can be relaxed. Assume that each consumer starts her shopping trip to s by visiting a stochastically determined shop $x_s \in R_s$. From there she continues by walking to other shops in the same way as above. The probability that a consumer first pops up in shop x_s is described by a unimodal density function $\psi_s(x_s)$ defined on the space R_s. Then the demand shop r_s faces can be written as $D_{r_s} = N_s t_s \int_{x_s \in R_s} \psi_s(x_s) \varphi_s(d) dx_s$ where d is again the distance between the arrival point x_s and shop r_s. It can be shown that the demand function D_{r_s} is concave and has its maximum in the same point as the underlying density function $\psi(x_s)$. We call this point again the centre of the shopping area.

Rent falls with the distance from the centre and will at a certain distance d^* become equal to the rent of the competing, residential use: $R(r_s(d^*)) = R_h$, where R_h is the rent of the residential land use. Distance d^* determines the optimal size of the shopping area. Figure 3 upper panel, depicts a shopping area that has an optimal size. Note that the optimal size of a shopping area is the larger the higher the demand for retail products D_{r_s} and the lower the rent of the competing residential land use R_h. This suggests that changes in the retail demand and residential land rents should in the long run lead to transformations of land at the edge of the shopping area, from retail to residential use or the other way around. This leads to Proposition 2a:

Proposition 2a. *Non-retail (mixed) land use concentrates at the edge of the shopping areas.*

In the short run land transformation is not always feasible, for instance due to zoning restrictions. In practice, shopping areas may thus be smaller or larger than optimal. In the first case the retail bid-rent at the edge is higher than the residential bid-rent and the rent experiences a discontinuous downward jump at the edge of the shopping area. In the second case the retail bid-rent at the edge is lower than the residential bid-rent. If the retail bid-rent is also lower than zero, vacancy arises, see Figure 3 middle panel. In this case the number of consumers visiting the shops at the edge of the shopping area is not sufficient to make these locations profitable even at a zero rent. This leads to proposition 2b.

Proposition 2b. *Vacancies concentrate at the edge of the shopping areas.*

Figure 3. Land gradient in shopping areas; the land market reaction to a fall in demand
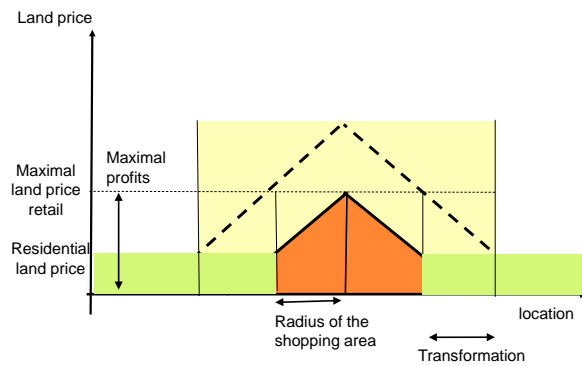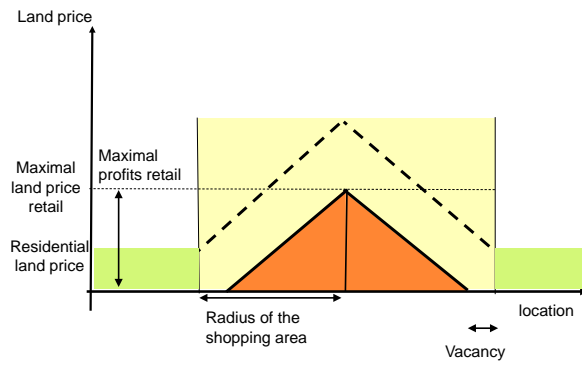
In the longer run vacant buildings are likely to be taken over by other land uses which can exploit the land profitably. This is illustrated in Figure 3 lower panel. From this figure we can derive predictions concerning dynamic adjustments to demand shocks.

Proposition 3. *A negative shock to demand results, in the short run, in a simultaneous fall in rents and a rise in vacancies. In the longer run, retail properties will be transformed into other properties, more so at the edge of the shopping areas.*

Propositions 1-3 will be tested on real data on rents, vacancies and transformations of land use in the period 2004-2014, containing the Great Recession.

3.2   Empirical specification

To test the predictions of Propositions 1 to 3 we use four different empirical specifications; these are presented in Table 1:

Table 1 Equations to be estimated

		equation
1	OLS Retail rents	$\ln P_{rst} = \alpha + \kappa L_{rst} + \varphi d_{rst} + I_s + T + u_{rst}$
2a	Probit mixed land use	$Pr[non-retail] = f_1(L_{rst}, d_{ist}, I_s, T)$
2b	Probit vacant shops	$Pr[vacant|shop] = f_2(L_{rst}, d_{ist}, I_s, T)$
3	Probit transformations retail to other use	$Pr[transformed] = f_3(L_{rst}, d_{ist}, I_s, T)$

where P_{rst} is the rent shop r located in shopping area s pays in year t, d is distance to the centre of the shopping area, L are structural and locational characteristics of the property (size, age, etc.), I_s are shopping area fixed effects, T is the time trend and u_{rst} is the idiosyncratic error term.

Summarizing, specification 1 estimates the rent gradient, the rent levels by shopping area and the yearly changes in the level of rents. Specifications 2a and 2b estimate the distance decay in the probability that a land lot within a shopping area does not contain a shop, either because the property has a retail function, but is vacant, or because the property has a non-retail function. Specification 2a also estimates the yearly dynamics in the level of vacancies and the vacancy rate by shopping area. Specification 3 looks at the transformations from retail to other use following the negative demand shock during the Great Recession.

4 Data

We exploit four unique datasets:

(i) A dataset with the characteristics of all the shops in the Netherlands during the time period 2004-2014. This dataset was collected by Locatus, the Dutch market leader in retail information. The following information about each shop is available: size, shop name, address and product category, geographical location (x and y coordinates), whether the shop belongs to a shopping area and if yes, to which one, whether the shop is part of a mall and whether it is vacant.

(ii) A dataset BAG (BasisAdministratie Gebouwen) including all the real estate properties in the Netherlands in 2014, containing the information on the function (retail, residential, etc.) and size of the property, as well as the functions it had in the preceeding 5 years. This dataset was made available by the Netherlands' Cadastre and Public Register Agency (Kadaster).

(iii) Two datasets on retail rent transactions. The first one covers the years 2004-2014 and was collected by Strabo, the Dutch specialist in commercial real estate. It contains information on new retail rent contracts that has been made publicly available through newspapers or Internet. Another database covers the years 2009-2014 and was collected by the real estate company Jones Lang Lasalle (JLL). It contains the Strabo rents 2009-2014 as well as not publicly available new retail rent contracts that were signed by JLL clients during the period in consideration.

Table 2 describes our data selection process. We are interested in properties located in larger shopping areas. The geographical definition of the shopping areas was performed by Locatus and is based on their knowledge of the retail market and their expert judgement. From some 106 thousand shops in the Netherlands, around 80% are located within shopping areas. The rest are small dispersed retail points like a bakery on the corner of a residential block. For this paper, we select larger shopping areas with more than 25 shops, as for smaller areas rent data are too thin. We ensure that the shopping areas are compact by removing stores at the edge if they are located at a distance from the main cluster and then test again whether the 25-shop criterion is met. We select shopping areas containing a mix of product categories with at least 10% being fashion. The latter criterion ensures dropping specialized shopping areas such as food plaza's and furniture malls. Applying these selection criteria reduces the number of shopping areas in our database from the original 2780 to 450 and the

number of shops from 80 thousand to 50 thousand. Finally, the number of shopping areas with known rents is some 300.

Only a quarter of the properties in the our shopping areas is retail: there are 50 thousand shops in the total of 190 thousand properties in our selection. The rest of the properties has another function, mainly residential. The intuition for this at the first glance surprising result is as follows. First, small retailers often live above their shops. Second, many of our shopping areas are located in cities where several stories buildings are common. Liu, Rosenthal and Strange (2016) shows that retail concentrates on the ground floors (plints) of these buildings and leaves other floors to other uses.

Figure 4 reports the location of the shopping areas in our selection, by municipality. The four largest cities, Amsterdam, Rotterdam, The Hague and Utrecht have the largest concentrations. The south of the country has relatively large concentrations too. Relatively few shopping areas are located in the periphery.

Table 2 Data selection shopping areas

|	Locatus		JLL	Strabo	BAG
	shopping areas	shops	rent trans.	rent trans.	all properties
	2004-2014, average/year		2009-2014	2004-2014	2014
initial database		106387	5994	7012	9 mln
located within shopping areas	2780	98939			
mktplace >=25 shops	625	78644			
not specialized, share fashion>0.1	587	61036			
compact	451	51694			
rents available JLL	321	45630	3398		188824
rents available Strabo	346	49518		4521	

Figure 4. Location of the shopping areas
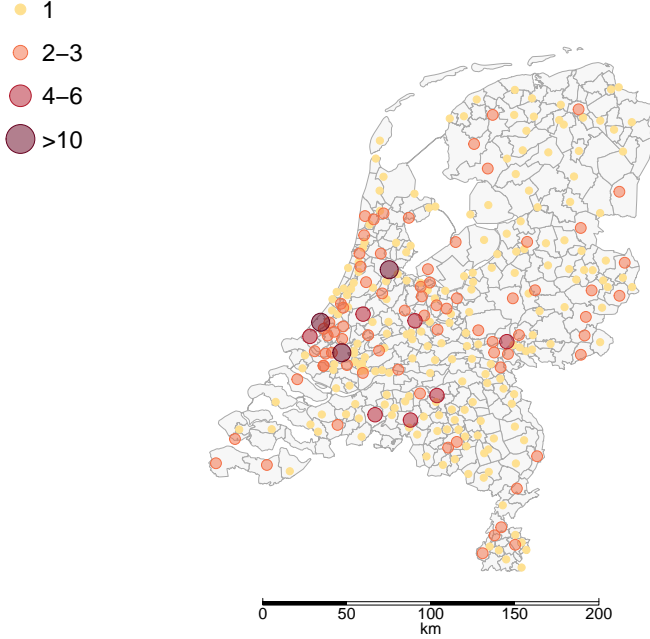
Table 3 reports the descriptive statistics of the data. An average shop in our data has a floor space of some 200 m^2, is located at a distance of 200 meter from the centre of its shoping area, has 30 other shops within a 250 meter radius and 300 monuments within a 1 kilometer radius. Some 10% of the shops are located in shopping streets and some 25% in shopping areas with zero parking costs. Around 20% are shops that belong to malls. We define malls as parts of the shopping areas that have been developed according to one plan of the same architect, those may be indoor or outdoor malls. They often have a single owner or manager. We expect that malls have ceteris paribus higher rent levels because a single manager can internalise the externalities shops exert on one another (Gould et al., 2005). An average shop has a probability of 8% to be vacant. Vacant shops are somewhat smaller and are located in areas with less touristic attractions (fewer monuments), but these differences are not significant. For 10% of the shops we know rents at some moment in time, the average rent being 300 euro per m^2 retail space per year. Shops with known rents do not significantly differ on observables from the average shop. Finally, as discussed above, three quarters of the properties in our shopping areas have a non-retail function.

	All properties		Shops		Vac.shops		Shops with known rents			
	BAG		Locatus		Locatus		JLL		Strabo	
	2014		2014		2014		2009-2014		2004-2014	
variable	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.	mean	st.dev.
Dependent variables										
rent (euro/m^2)	-	-	-	-	-	-	304.42	287.64	292.12	205.90
vacancy 1/0 (in %)	-	-	8.45	27.81	-	-	-	-	-	-
# shops within 250m	25.06	13.85	30.99	16.49	27.82	14.73	34.45	18.08	36.22	18.88
non-retail property 1/0	0.76	0.43	-	-	-	-	-	-	-	-
Structural charact.										
m2	135.11	142.40	188.78	419.14	170.73	231.12	198.76	294.42	205.74	248.28
constructed before 1900	0.20	0.40	0.17	0.38	0.14	0.34	0.21	0.40	0.19	0.39
constructed after 2000	0.14	0.35	0.18	0.38	0.29	0.45	0.18	0.39	0.18	0.38
Location charact.										
dist. centre shopping area (m)	268.48	251.58	200.37	201.15	211.64	175.62	219.05	189.80	201.02	174.58
mall 1/0	0.12	0.32	0.23	0.42	0.20	0.40	0.17	0.38	0.19	0.39
shopping street 1/0	0.14	0.35	0.10	0.29	0.09	0.28	0.09	0.28	0.08	0.27
# monuments within 1km	353.60	740.43	281.31	624.98	187.72	398.67	325.01	593.09	254.50	442.91
free parking 1/0	0.21	0.41	0.25	0.43	0.21	0.41	0.17	0.38	0.18	0.39
#properties	188824		45630		4770		3398		4521	

5 Estimation results spatial structure

In this section we test the predictions of Proposition 1 and 2 about the spatial structure of the shopping areas. Table 4 and 5 report the results of estimating regressions 1, 2a and 2b from Table 1. Table 4 reports the baseline results, Table 5 reports the results when accounting for heterogeneity between shopping areas.

The estimated coefficients support our predictions. The rent gradient is negative, as expected (see the first column in both tables). Rents decrease with up to 18% with every 100 meter distance from the centre of the shopping area, the effect becoming flatter towards the edge. Heterogeneity between shopping areas appears to be sizable. For instance, in

two-dimensional shopping areas with an average number of touristic attractions and paid parking the rent gradient is -26% per 100 meter. In a shopping street with free parking it is -10%. The upper panel of Figure 5 shows the rent gradient for four other types of shopping areas. The two datasets on rents we use give very similar results; this provides us with additional security about the insights.

The vacancy rate rises with factor 1.2 with every 100 meter, the effect becomes flatter with distance. The probability that a property has a non-retail function increases with a factor 0.6 per 100 meter. Thus, closer to the edge of a shopping area land use gets more mixed and more vacancy appears. Here again, as expected, shopping areas where people are likely to stay longer as well as shopping streets have a flatter distance effect. However, the statistical significance of these differences is low. Figure 5 illustrates these distance effects for different types of shopping areas.

Table 4 Rent gradient and distance effect vacancies and retail space use

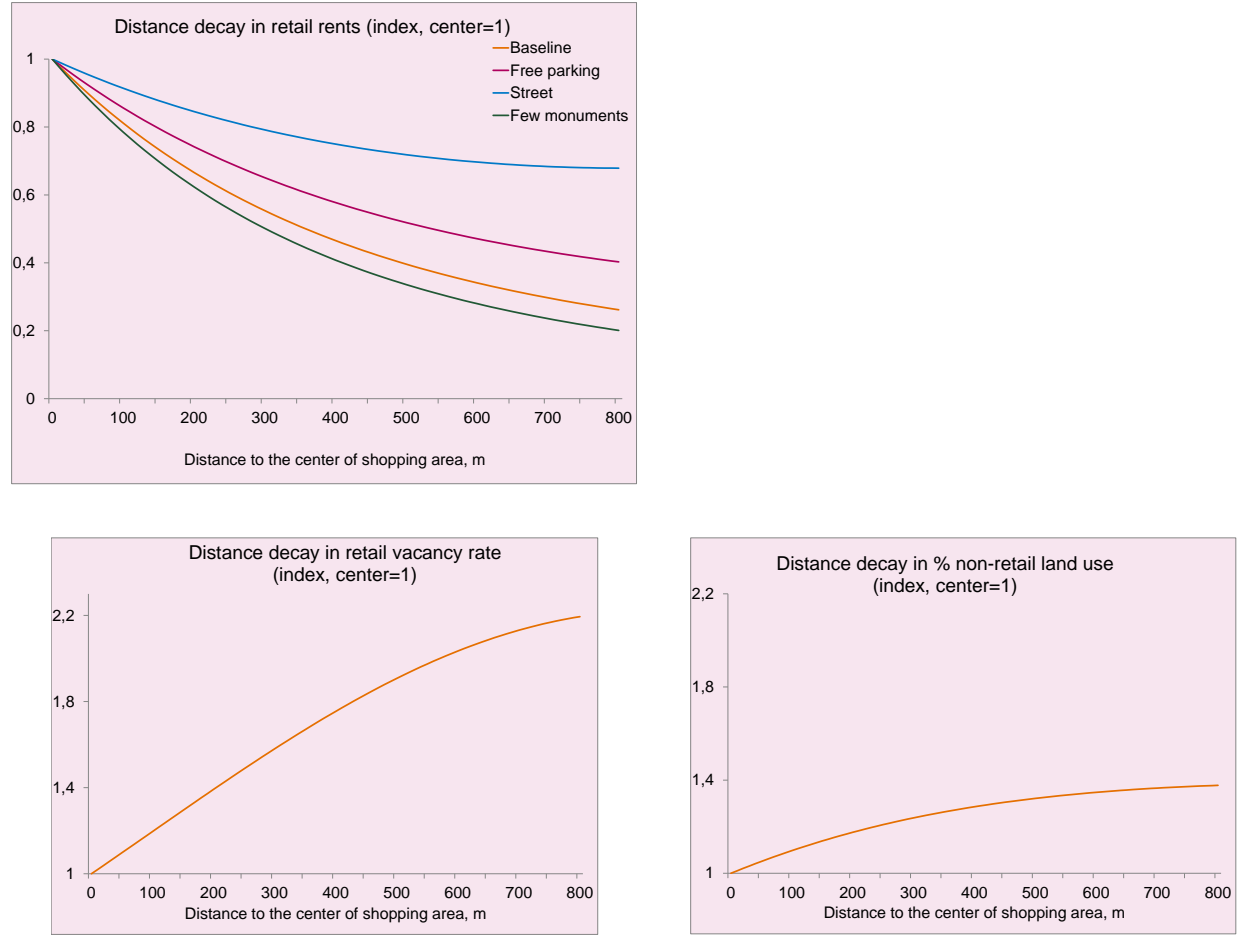| variable	Rents JLL 2009-2014		Rents Strabo 2004-2014		Vacancies 2014		Non-retail use 2014	
	coef	t-val	coef	t-val	coef	t-val	coef	t-val
dist.to centre shopping area (100m)	-0.177	(8.36)	-0.172	(7.01)	0.105	(6.37)	0.188	(7.24)
dist squared	0.007	(2.72)	0.008	(2.30)	-0.006	(3.97)	-0.010	(5.11)
floor space (log, m^2)	0.700	(46.73)	0.630	(51.74)	0.019	(2.00)	-0.586	(25.54)
constructed before 1900	0.068	(2.95)	0.058	(3.18)	-0.046	(1.50)	-0.060	(2.16)
constructed after 2000	-0.038	(1.22)	0.018	(0.77)	0.322	(11.07)	0.351	(9.14)
part of a mall cluster	0.344	(6.74)	0.208	(4.25)	0.004	(0.10)	-0.533	(9.29)
intercept	7.299	(96.44)	7.659	(90.82)	2.929	(5.43)	5.035	(15.79)
year dummies	YES		YES		NO		NO	
(Mundlak) shopping area fixed effects	YES		YES		YES		YES	
(pseudo-)R^2	0.597		0.571		0.021		0.104	
# observations	3398		4521		45630		188824	
# fixed effects	321		321		321		321	

Coefficients by the structural and locational characteristics of a shop are in line with the intuition. Larger shops command lower rent by m^2 floor space and are more likely to be

vacant. Larger properties are less likely to have a non-retail function. Historical buildings command higher rents, while newly constructed properties are more likely to be vacant or non-retail. Malls have higher rents and a lower probability of housing vacant shops or non-retail properties.

Table 5 Heterogeneity in rent gradient and distance effect vacancies

	Rents JLL		Rents Strabo		Vacant		Non-retail use	
	2009-2014		2004-2014		2014		2014	
variable	coef	t-val	coef	t-val	coef	t-val	coef	t-val
dist.to centre shopping area (100m)	-0.258	(10.84)	-0.203	(8.01)	0.143	(5.79)	0.278	(7.96)
dist squared	0.006	(2.43)	0.008	(2.37)	-0.004	(2.38)	-0.007	(-3.24)
cross-effect distance x char. of shopping area								
zero parking cost (1/0)	0.054	(3.20)	0.031	(2.37)	-0.020	(0.90)	0.040	(1.96))
shopping street (1/0)	0.119	(5.38)	0.109	(2.23)	-0.037	(1.12)	-0.117	(4.77)
log monuments within 1km	0.015	(2.57)	0.003	(0.51)	-0.009	(1.60)	-0.018	(2.66)
floor space (log, m^2)	0.701	(48.53)	0.631	(51.92)	0.017	(1.86)	-0.585	(26.07)
constructed before 1900	0.063	(2.85)	0.056	(2.95)	-0.047	(1.56)	-0.063	(2.40)
constructed after 2000	-0.038	(1.29)	0.016	(0.70)	0.324	(11.18)	0.350	(8.95)
part of a mall cluster	0.325	(6.64)	0.201	(4.16)	0.009	(0.23)	-0.517	(9.05)
intercept	7.302	(91.49)	7.659	(90.83)	-2.329	(3.84)	5.211	(13.67)
year fixed effects	YES		YES		NO		NO	
(Mundlak) shopping area fixed effects	YES		YES		YES		YES	
(pseudo-)R^2	0.605		0.576		0.024		0.107	
# observations	3398		4521		45630		188824	
# fixed effects	321		321		321		321	

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Figure 5. Rent gradient and distance effect vacancy and non-retail use

Distance decay in retail rents (index, center=1)

— Baseline
— Free parking
— Street
— Few monuments

Distance to the center of shopping area, m

Distance decay in retail vacancy rate (index, center=1)

Distance to the center of shopping area, m

Distance decay in % non-retail land use (index, center=1)

Distance to the center of shopping area, m

Our data contain retail properties that were developed as a part of a mall and set up by the same architect. Malls may have a different spatial structure than the rest of the shopping areas. We test for the robustness of our results in Table 6 by dropping shops that are part of a mall. This does not lead to significant changes in the point estimates of the coefficients.

Table 6 No malls

| | Rents JLL | | Rents Strabo | | Vacant | | Non-retail use | |
	2009-2014		2004-2014		2014		2014	
variable	coef	t-val	coef	t-val	coef	t-val	coef	t-val
dist.to centre shopping area (100m)	-0.258	(8.84)	-0.238	(7.81)	0.156	(5.69)	0.243	(6.41)
dist squared	0.007	(2.71)	0.010	(3.07)	-0.005	(2.84)	-0.007	(3.35)
cross-effect distance x char. of shopping area								
zero parking cost (1/0)	0.047	(3.07)	0.036	(2.10)	-0.009	(0.43)	0.039	(1.92)
shopping street (1/0)	0.125	(5.19)	0.124	(4.38)	-0.044	(1.36)	-0.100	(4.19)
log monuments within 1km	0.013	(2.17)	0.006	(1.03)	-0.008	(1.62)	-0.015	(2.09)
floor space (log, m^2)	0.687	(43.23)	0.613	(46.06)	0.026	(2.53)	-0.559	(23.77)
constructed before 1900	0.069	(3.23)	0.057	(3.02)	-0.032	(1.04)	-0.069	(2.79)
constructed after 2000	-0.066	(2.13)	-0.20	(0.88)	0.374	(3.57)	0.349	(9.01)
intercept	7.408	(85.48)	7.809	(93.35)	-1.652	(2.68)	4.376	(13.74)
year fixed effects	YES		YES		NO		NO	
(Mundlak) shopping area fixed effects	YES		YES		YES		YES	
(pseudo-)R^2	0.575		0.559		0.030		0.084	
# observations	2809		3675		35105		160141	
# fixed effects	261		283		298		291	

# 6   Retail during the Great Recession and policy implications

In this section we exploit a time series 2004-2014 to test whether the data support the two predictions of Proposition 3:

- In the short run a drop in consumption results in a simultaneous drop in rents and a rise in vacancies,

- In the longer run it leads to transformations from retail to other land use, especially at the edge of the shopping areas.

Our data include the period of the Great Recession 2008-2014, in which the Netherlands was hit by a large and prolonged negative consumption shock. The left panel of Figure 7

shows that consumption of goods as well as retail sales in the Netherlands decreased with some 10% in that period. The right panel presents the time fixed effects for rents and vacancies estimations, 2004-2014. Here we use the same specifications as in columns 2 and 3 of Table 4, adding the extra years to the probit estimation of the vacancies. The behaviour of the rents and vacancies is in line with the predictions of our theoretical model. Before the Great Recession neither rents nor vacancies changed much in levels. Between 2008 and 2014 rents fell with 20%, and simultaneously, vacancies rose with a factor 1.6.

Figure 7. Retail consumption decreased. Simultaneously, rents droped and vacancies rose.
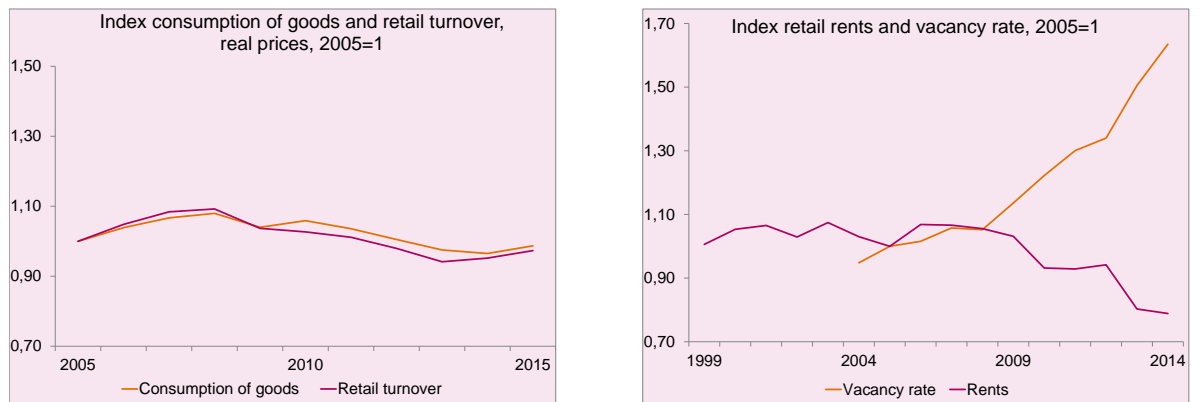
We turn now to the transformations from retail to another use. We focus on properties that existed in 2010. Some 1500 properties that had retail as the only function in 2010, were transformed into another use between 2010 and 2015. Table 8 reports results from a probit model explaining the probability of being transformed from retail to another use from the structural characteristics of the property and its location within the shopping area. As predicted by Proposition 3, the probability of transformation increases with a factor 1.3 with every additional 100 meter distance to the centre of the shopping area. Newer properties are more likely to be transformed and properties located in malls less likely.

Table 8 Rent gradient in transformations

	Probit transformation from retail to other use	
variable	coef	t-val
dist.to centre shopping area (100m)	0.119	(5.69)
dist squared	-0.007	(4.93)
floor space (log, m^2)	-0.026	(0.74)
constructed before 1900	-0.007	(0.16)
constructed after 2000	0.392	(5.42)
part of mall	-0.583	(7.54)
intercept	-3.198	(2.02)
(Mundlak) shopping area fixed effects	YES	
(pseudo-)R^2	0.044	
# observations	39378	
# fixed effects	321	

As we showed in the previous section, during the Great Recession the vacancy rates in the Netherlands grew with a factor 1.6. While some of this vacancy will disappear following the economic recovery, another part is likely to be structural. One of the reasons is the substitution of brick-and-mortar shopping with online shopping. Indeed, Figure 8 illustrates that the share of online shopping has risen considerably during the last 10 years. Still, this share in the Netherlands is rather limited, compared with other European countries and the United States and is likely to grow further in the coming years, arguably leading to more structural vacancy (see also Dutch Central Bank, 2015). Transformations can help eliminate the structural vacancy. For a transformation to be attractive, it is necessary that a location is more attractive for an alternative, non-retail use. The above analysis suggests that most of transformed shops became dwellings. Figure 9 shows the dynamics of retail and residential property values between 2005 and 2015. During the Great Recession, residential land decreased (much) less in value than retail land. If this divergence process continues, transformation of more vacant retail properties might become attractive in the years to come.
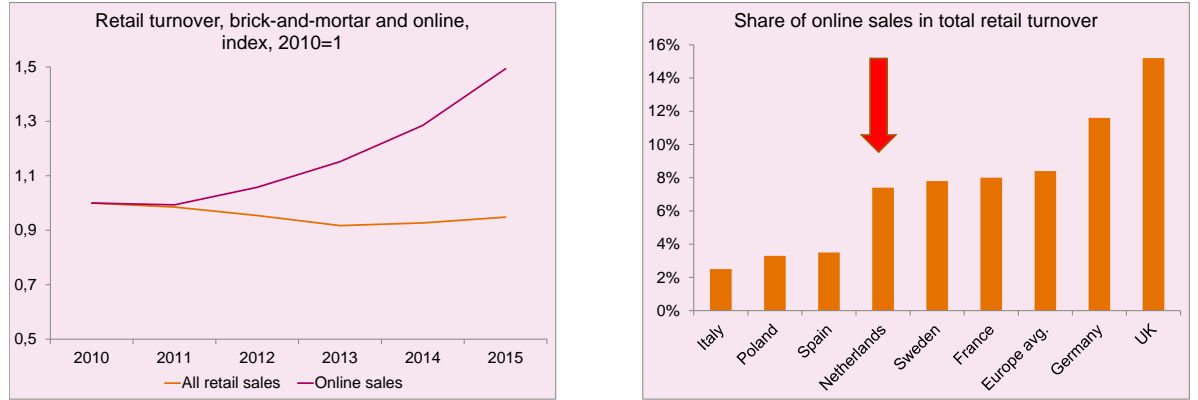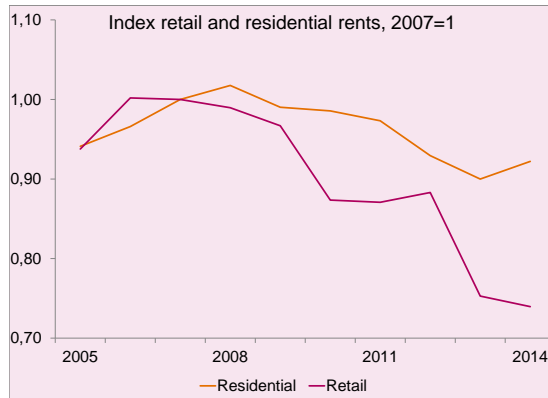
Figure 8. Online shopping in the Netherlands

Figure 9. Dynamics of residential and retail property prices (index, 2007=1)

7   Conclusion

This paper is the first to study theoretically and empirically the land use in urban shopping areas and the competition between residential and retail land in a city. We have developed and tested econometrically a model describing the structure, size and floor rents in different shopping areas including both downtowns, as well as shopping streets and districts. We have shown that the spatial structure of all these shopping areas resembles that of a monocentric

city. It features one pronounced centre where the level of rents is the highest. Rents decrease with up to 18% with every 100 meter extra distance from this centre, the effect becoming flatter towards the edge. In shopping streets, areas with zero parking costs and areas with a large supply of historical sights the rent gradient is up to two times smaller. Near the edge of a shopping area rents are the lowest and the retail land use competes with other land uses. As a result, vacancies and non-retail land use tend to cluster near the edge of the shopping areas.

We have exploited the prolonged drop in consumption during the Great Recession in the Netherlands to provide additional support for our model. The model predicts that a negative demand shock should lead to a simultaneous drop in rents and rise in vacancies and, in the longer run, to transformations from retail to other land use, mostly at the edge of the shopping areas. This is exactly what we see in the data. During 2008-2014 in the Netherlands consumption of goods and retail sales dropped with 10%. Retail rents declined in the same period with 20%, and simultaneously, vacancies increased with a factor 1.6. Retail properties were transformed to other land use, more so near the edge of the shopping areas.

Our insights are especially interesting in the light of the recent developments in the market of retail. Demand for brick and mortar shopping has been decreasing in recent years, due to the Great Recession and the rise of online retail. It is likely that a part of this effect is structural. Our model suggests that a negative shock in demand necessarily leads to smaller shopping areas as some locations at the edge become unprofitable for retail use. In regions and locations with high enough demand for land, contraction of the shopping areas can be achieved by market forces, as a result of transformation of retail land to other use. In declining cities and regions, this transformation is less likely to happen by itself and public policy may be needed to prevent empty spaces in downtowns.

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