What do price responses to local entry tell us about competition?
An application to repair pricing by car dealers

Abstract

We develop and apply a framework to measure the intensity of competition in a market. We show that a strong price response to local entry implies that a market is not competitive. We estimate the effect of changes over time in the number of local repair firms on the setting of repair prices by car dealers for the Netherlands. We use microdata about car repair prices with, rather uniquely, micro controls. We distinguish between changes in the number of car dealers specialised in the same brand, specialised in another brand and generic repair firms. We demonstrate that prices of car dealers respond to the presence or entry of car dealers that are specialised in the same car brand, not to dealers of other brands. Furthermore, we find a low price elasticity for local entry, suggesting that the market is fairly competitive.

Keywords: relevant market, measurement of competition, spatial competition, car repair firms

JEL-codes: L13, L84
1. Introduction

Measuring the level of competition has been a challenge for academics and policy makers for the past few decades. Commonly used concentration measures (e.g. the Herfindahl-Hirschman index or the \( C_n \)-index, defined as the combined market share of the \( n \) largest firms) treat the intensity in competition as exogenous and fixed. Moreover, these indices have a hard time handling industries with differentiated products (Lijesen, 2004). The Price cost margin (or Lerner index), another commonly used measure, does not always reflect the true level of competition (Boone, 2008). Moreover, calculating the price cost margin requires information on marginal costs. The alternative, Boone’s relative profit difference indicator (Boone, 2008) requires information on the cost efficiency of firms in the market.

Policy makers have also struggled with a similar question, as becomes clear from the definition and practical use of the concept on the relevant market. This concept is used in antitrust law and merger control, both in the US and the EU, as well in many other countries. The hypothetical monopolist test, as described in the 2010 Horizontal Merger Guidelines, provides an indication of how to indicate a relevant market, but the application of that test is not without problems (see, e.g., Ivaldi and Lőrincz, 2011; Elizalde, 2012). ¹

This paper adds to the literature by developing and applying a framework that provides a measure of competition intensity (the reverse of market power) without too much data requirements. The framework is based on Hotelling’s model of spatial competition, but the qualitative findings have a wider validity. We establish that the intensity of competition can be measured by short-run response of prices to entry and demand shocks.

Other authors have analyzed price responses to establish whether goods can be thought to belong to the same ‘relevant market’ (and hence compete with each other). Juselius and Stenbacka (2011) apply cointegration analysis to assess whether geographically distinct markets for electricity in Scandinavia can be seen as one. Their analysis focuses on one dimension of product differentiation (i.e. distance) and assess whether prices follow similar patterns between regions, implying that they respond to the same developments in demand and supply. Their approach is well-suited for an otherwise homogeneous good, such as electricity. Our approach

allows for differentiation on geographical distance and differentiation in product space at the same time.

We apply our framework to car repairs by brand-specific car dealers in the Netherlands. About half of car repair firms are also dealers of a specific car brand (e.g. Mercedes). Brand dealers strongly depend on single car manufacturers in many ways. The European Commission allows vertical agreements between car manufacturers and car dealers, as these agreements are thought to have efficiency enhancing effects that would outweigh the anti-competitive effects (see EC, 2002). In the current context, car manufacturers or their importers may also influence the decision of dealers to open or to close, and where to locate. Given consumer preferences for cars to be repaired by specialised dealers and integrated relations in the car market (Langlois and Robertson, 1989; Masten et al., 1989), it seems plausible that car manufacturers have a certain amount of market power, enabling them to reduce the number of dealers. Hence, from a welfare perspective, it is likely that there are too few car dealers (i.e., the distance between dealers is too long). When estimating the effect of distance between competing firms on prices, an endogeneity problem may arise due to the presence of unobserved characteristics of the location. Locations that are attractive for unobserved reasons will attract higher rents and hence induce higher prices. At the same time, it is plausible that the number of competing firms will be higher at these locations, causing an endogeneity issue. This issue is discussed at length in the large literature about the effect of agglomeration on wages and commercial building prices (Ellison and Glaeser, 1999, Ellison et al., 2010 and Drennan and Kelly, 2010). In the agglomeration literature, several approaches are introduced to deal with this endogeneity issue (e.g., an instrumental variables approach). In the current paper, we deal with unobserved time-invariant variables by using panel data for a period of three years. In essence, we analyze changes over time (in prices as well as in distance to local competitors) while using postcode fixed effects. Such an approach, despite its advantage of being easy to apply and to interpret, is hardly used in the agglomeration literature, because agglomeration hardly changes over time.

In the context of panel data analysis with fixed effects, the presence of time-varying variables cannot be completely ignored. Changes over time in the supply cost of car repairs are likely small, because the local supply curve will usually hardly shift over time, but the local demand for car repairs may shift substantially. For example, the development of a new suburb, which induces population growth, and therefore car ownership, may have a substantial effect on
car repair demand. Ignoring these demand shifts, will likely result in a negative bias of the effect of distance between car repair firms on prices (because increased demand will increase prices and through increased supply the distance between car repair firms is reduced). We will deal with these demand shifts by controlling for car ownership in the neighborhood of the car repair firm.

The remainder of this paper is organized as follows. Section 2 describes the framework of our analysis, followed by our empirical specification in section 3. Section 4 provides a description of the data used. We present our empirical results in section 5 and conclude in section 6.

2. Theoretical Framework

Hotelling’s (1929) analogy of spatial competition analyzes the location choice of two firms on Main Street. Consumers are distributed uniformly on segment [0,1] and are assumed to buy exactly one unit of a homogeneous product, offered by two firms. Every consumer chooses a firm to buy from, based on the mill price of each firm and the transport costs to that firm.

Our theoretical framework builds upon the pricing stage of a linear spatial competition model with quadratic transport costs (d’Aspremont et al., 1979). We limit our analysis to the pricing stage alone, as we are interested in short term adjustments. We further stress the short term nature of the model by assuming a quadratic (i.e. convex) production cost function, expressing the fact that capacity cannot be adjusted in the short term and overutilization of capacity is costly.

Consumers of a homogenous good are assumed to be uniformly distributed on a line segment (0,1) with density $n$. The market is served by two firms, A and B, located at $x_A$ and $x_B$. Without loss of generality, we assume that firm B is located to the right of firm A ($x_B>x_A$). Moreover we assume that $0<x_A+x_B<2$. This assumption allows firms to locate outside the inhabited part of the market, but not both on the same side of the market. 2 Every consumer buys exactly one unit of the good, and they buy it from the shop for which the sum of the mill price

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2 Symmetry implies that $x_A>\frac{1}{2}$ or $x_B<\frac{1}{2}$ would not make sense, as the other firm could simply jump over to the other side of the market. The unrestricted Nash equilibrium in locations (with no or linear production costs) is $-\frac{1}{4}$, $\frac{1}{4}$ for simultaneous entry and $-\frac{1}{2}$, $\frac{1}{2}$ for sequential entry, see Tabuchi and Thisse, 1995.
and the quadratic transport costs are lowest. The consumer that is indifferent between buying from shop A and B, is located at \( \hat{x} \), such that:

\[
p_A + (\hat{x} - x_A)^2 = p_B + (x_B - \hat{x})^2. \tag{1}
\]

We solve this equation for \( \hat{x} \):

\[
\hat{x} = \frac{p_B - p_A + x_B^2 - x_A^2}{2(x_B - x_A)}. \tag{2}
\]

All consumers to the left of \( \hat{x} \) buy the good at shop A, implying that the demand for shop A equals \( n\hat{x} \) and the demand for shop B equals \( n(1-\hat{x}) \). For ease of notation, we define \( d = x_B - x_A \) and \( R = x_B + x_A \), where \( d \) denotes the distance between the shops and \( R \) measures their joint position, with \( R=1 \) reflecting symmetry in locations. We rewrite:

\[
\hat{x} = \frac{p_B - p_A + \frac{1}{2}R}{2d}. \tag{3}
\]

Hotelling’s model contains a trade-off between the so-called market stealing effect and the market power effect. The market stealing effect urges firms to move towards the centre of the market to grab a larger market share, whereas the market power effect implies that price competition is softened if firms are further apart. Equation (3) clearly reflects these two effects, with \( R \) having a positive impact on the market share of firm A and \( d \) lowering the impact of the price difference on market share. Although we limit our analysis to the short term and hence to the pricing stage, the impact of distance on the severity of competition is crucial in our analysis. We show here that distance, \( d \), is a good measure for market power in this model setup, and will use it as such in the empirical analysis. Proposition 1 below regards the Nash equilibrium in prices.

**Proposition 1:** The Nash equilibrium in prices exists and is given by:

\[
p_A^N = \frac{(2 + R)d + 2cn}{3d + 2cn}(d + cn), \quad p_B^N = \frac{(4 - R)d + 2cn}{3d + 2cn}(d + cn). \tag{4}
\]
Proof: Firm A maximizes profits equal to revenue minus quadratic production costs:

\[ \pi_A = p_A n \hat{x} - c (n \hat{x})^2 = p_A n \left( \frac{p_B - p_A + \frac{1}{2} R}{2d} \right) - c \left( \frac{p_B - p_A + \frac{1}{2} R}{2d} \right)^2, \]  

(5)

where \( c > 0 \). The first-order condition for profit maximization and solving for \( p_A \) provides the best response in prices for firm A:

\[ p_A = \frac{(d + cn)(p_B + Rd)}{2d + cn}. \]  

(6)

Similarly, we derive the best response in prices for firm B:

\[ p_B = \frac{(d + cn)(p_A + (2 - R)d)}{2d + cn}. \]  

(7)

The market stealing effect and market power effect are clearly reflected in the Nash price, with \( R \) positively impacting the price of firm A and negatively impacting the price of firm B. A larger value of \( R \) implies that firms are on average more to the right, placing the left hand firm A closer to the centre. Imposing symmetry on the model (i.e. \( R=1 \)) simplifies (4) to

\[ p_A^N = p_B^N = d + cn, \]  

which has the intuitive interpretation of price equal to marginal costs plus a mark-up. The mark-up is entirely determined by distance between the firms.\(^3\) In the main text of the paper, we will maintain the assumption of symmetry in locations to simplify notation (our results also hold in the more general case and are available upon request).

Proposition 2: The elasticity of prices with respect to consumer density lies between 0 and 1 and it is strictly decreasing in distance:

Proof: substituting \( R=1 \) into the result of proposition 1 yields: \( p = p_A^N = p_B^N = d + cn \), The elasticity with respect to consumer density is then given by:

\[^3\text{Note that Hotelling (1929) used distance as a metaphor for product differentiation. throughout our paper, } d \text{ can also be interpreted as a measure for product differentiation.}\]
\[ \varepsilon_n^p = \frac{\hat{c}p}{\hat{c}n} \frac{n}{p} = \frac{cn}{d + cn}. \]  

(8)

which ranges from 0 to 1 and is decreasing in distance.

The interpretation of this result is straightforward and in line with common intuition; if market power increases, prices become less cost-oriented and hence the impact of a cost change is translated to a price change to a lesser extent. In a fully competitive market, price equals marginal costs and any cost increase would be translated to an equal price increase. This is confirmed by that for \( d=0 \) (8) yields a price-cost elasticity of one.

Proposition 3: The elasticity of prices with respect to distance between firms lies between 0 and 1 and is strictly increasing in distance.

Proof:

\[ \varepsilon_d^p = \frac{\hat{c}p}{\hat{c}d} \frac{d}{p} = \frac{d}{d + cn}. \]  

(9)

Again, the impact of distance follows directly. The result of proposition 3 is the counterpart of proposition 2. If competition decreases, the mark-up and hence the price increases. The larger the share of the mark-up in the price, the larger the elasticity will be. We note that (9) reflects the Lerner index, a common measure of market power, but (9) does not require information on the cost function to be estimated.

Proposition 3 also provides information on the boundaries of the relevant market, either in product space or geographical space. If firms do not belong to the same relevant market, the distance between them does not affect prices and hence the price elasticity of distance would be zero. We conclude that if the number of firms (on a market of fixed size) negatively affects prices if and only if firms belong to the same relevant market. This implies that we can test whether (groups of) firms compete in the same relevant market by evaluating the impact of distance on prices. The observation that propositions 2 and 3 are counterparts leads to proposition 4.
**Proposition 4:** The elasticity of prices with respect to distance between firms and the elasticity of prices with respect to consumer density add up to unity.

Proof: from propositions 2 and 3, it immediately follows that:

\[
\varepsilon_n^p + \varepsilon_d^p = \frac{cn}{d + cn} + \frac{d}{d + cn} = 1. 
\] (10)

This proposition is relevant as it provides a straightforward way to test empirically whether the empirical model is correctly specified.

The qualitative conclusion to be drawn from propositions 2 and 3 is that one can recognize the competitiveness of a market by its price responses to either entry or to an increase in demand. The more competitive a market is, the stronger its price response to an increase in demand is, relative to its price response to entry of another firm (or a decrease in the distance between firms). This qualitative conclusion does not depend on the model structure used here, but holds for any market with upward sloping short run marginal costs.

3. **Empirical Specification**

In this section, we set out to provide a specification that allows us to find real life values associated with propositions 2 and 3 and hence assess the competitiveness of the car repair market. Moreover, we will test whether the condition expressed in proposition 4 holds, as a way to test our specification.

We use information about car repair prices of individual repairs by approximately all car dealers in the Netherlands. Rather unusual, we also have information about the type of the repair and information about the brand of the car which is repaired. We know the location of **all** car repair firms based on its 4 digit zip code (including generic repair firms). We use Euclidean distances between each of the firms and distances to potential customers.\(^4\)

\(^4\) Areas defined by zip code are pretty small in terms of population as well as in geographical space. Each municipality has a distinct zip code. In large municipalities, a zip code area contains about 5,000 households. In small municipalities, it is usually less. The within zip code area driving time will be usually a couple of minutes. We focus on the Netherlands which has a very high population density and a high-density road network. The use of Euclidean distances is then usually appropriate. We emphasize that any random
In the context of car repairs, it makes sense to think that repair firms differentiate based on brand and geographical distance. In our empirical specification, we will take this into account: we will distinguish between competition from dealers that specialize in the same brand, dealers that specialize in another brand and other firms that do generic repairs.\(^5\)

Moreover, it is conceivable that repair firms also differentiate based on the type of repairs, as suggested by the simple observation that some repair firms specialise in certain repairs (e.g., changing tires). The literature furthermore suggests that for some types of repairs, the brand orientation of consumers is stronger than for other types of repairs, because the standard agency problem related to the quality of repair will be stronger for some repairs than for others (Schneider, 2012). For example, the quality of the replacement of a tire can be examined by most consumers with limited knowledge about cars, so replacing tires could be done by any repair firm, whereas consumers are more likely to prefer a brand specific repair firm for engine repairs. For this reason, in our empirical specification, we will estimate separate models for the type of repair.

In the theoretical framework, we ignore two factors that might affect prices. First, cost differences of repairs, which may exist between the different types of repair, types of car and different locations (wages, rents of the building). Second, differences in spatial demand for car repairs, which mainly depend on the number of potential customers close to the firm. Both factors will be explicitly controlled for in the empirical specification.

Our main interest is in the effect of spatial competition between firms on prices. For each repair firm \(i\), we know the distance to each location \(k\) (which is constant over time). Note that we can’t exactly follow the theoretical framework here by using (average) distance as an indicator. This is easily clarified by an example. Suppose that a firm has one competitor, located at 2 kilometers distance. A third firm enters and locates at a distance of 3 kilometers. The entry of the third firm will likely increase the level of competition, but the average distance will also measurement error in our distance measure creates a downward bias in the effect of distance on prices. Hence, if measurement error is relevant, our estimates are underestimates of the true effect.

\(^5\) The framework allows for distinguishing between specific brand-pairs, e.g. Volkswagen versus Audi, to assess the impact of a specific merger. The number of possible brand pairs is however too large to take all combinations into account.
increase. This implies that average distance does not correctly measure the market power effect from our theoretical framework. Instead, we sum the presence of competitors, while using a distance decay function (see below). This reverses the sign of the price elasticity with respect to distance.

We wish to take into account that firms differ in types of brand. So, for each location $k$, we distinguish between the number of firms that are specialized in the same brand, denoted by the variable $S_{kt}$, the number of repair firms that specialize in another brand, denoted by the variable $O_{kt}$, and the number of generic repair firms, denoted by $G_{kt}$ (the latter group may specialize in certain activities, e.g., changing tires, but not in brands).\(^6\) We measure (potential) demand for car repairs -- so potential customers -- at location $k$ by the number of cars registered in a zip code area, denoted by $N_{kt}$.

It is plausible that the effect of the presence of competing firms and potential customers at $k$ diminishes with the distance between the retail firm and location $k$. We take distance into account in two ways. First, we set a distance band, beyond which competitors are no longer taken into account (e.g., within 20 km of the firm).\(^7\) Second, we use a standard exponential distance decay function, where $d_{ik}$ reflects the distance between zip code areas $i$ and $k$. This decay function depends on a parameter $\lambda$ which is not simultaneously estimated with the other parameters but exogenously set (we will examine a wide range of parameters for $\lambda$, as well as several values for the distance band).\(^8\) We estimate a loglinear model including a standard distance-decay specification. The price of repair $j$ of a car with a certain brand at repair firm $i$ at time $t$ is then written as follows:

$$
\ln p_{ijt} = \delta_1 \sum_k S_{ik} e^{-\lambda d_{ik}} + \delta_2 \sum_k O_{ik} e^{-\lambda d_{ik}} + \delta_3 \sum_k G_{ik} e^{-\lambda d_{ik}} + \kappa \sum_k N_{ik} e^{-\lambda d_{ik}} + \beta \mathbf{C}_{ijt} + \gamma \mathbf{R}_{ijt} + \mu_t + \epsilon_{ijt}
$$

\(^6\) A number of repair firms are specialised in two different brands. This will be taken into account in the empirical analysis.

\(^7\) By defining (relatively small) market areas, we are able to explore different spatial weighting schemes within the market area, while avoiding the issue that spatial competition measures of different locations are strongly correlated.

\(^8\) In the empirical analysis, we have experimented with many different distance decay specifications. The results appear to be rather insensitive to the type of specification.
where $\delta_1$ captures the effect of the weighted number of competitors repairing the same car brand, which will be labelled as same-brand competitors, $\delta_2$ captures the effect of the weighted number of competitors which repair other brands, and $\delta_3$ captures the effect of the weighted number of competitors which do not specialise into brands; $\kappa$ captures the effect of weighted number of cars. Furthermore, $C_{ijt}$ is a vector of car characteristics (e.g. mileage, type of fuel, brand), and $R_{ijt}$ is a vector of repair characteristics (e.g., number of parts replaced). These two vectors account for car and repair specific cost differences that may arise.

Moreover, as emphasized in the introduction, we use location fixed effects in the above specification, captured by the location-specific term $\mu_i$. This term captures all time-invariant location-specific impacts on costs. One disadvantage of including this location fixed effect is that we only identify the short-run effect of changes in distance to other firms. Because the short-run effect is usually smaller than the long-run effect, it is plausible that our estimates are underestimates of the long-run effect.

We have to contemplate the possibility of the endogenous nature of the (weighted) number of competitors (see, similarly, Basker, 2005). It seems reasonable to assume that the number of firms will increase as a result of demand shocks which are unobserved (by us, but anticipated by firms), which increase the repair price. Consequently, when we do not control sufficiently for changes in demand, our estimates will be downward biased.\footnote{This assumption is confirmed by our data analysis where it appears that the effect of $\delta_1$, the effect of the number of same-brand competitors, is biased towards zero when we do not control for number of cars. However, when we control for additional demand indicators, the point estimate hardly changes.}

So, what about unobserved supply shocks? We focus on changes of prices of incumbent firms, so seemingly relevant examples, such as a new industrial area that is opened close to a highway which is attractive for car dealers, and therefore reduces car repairs prices, do not apply. Only when incumbent, as well as firms that consider entry, correctly anticipate reductions in repair costs in certain locations, then it is in principle possible that the number of firms will increase in these locations entirely for endogenous reasons. In this case, $\delta_1$, $\delta_2$ and $\delta_3$ will be estimated to be negative even in the absence of any effect. One can deal with this issue given the assumption that changes in these unobserved local costs are general and not specific to the three
types of car repair firms. We believe that this assumption is extremely plausible. Hence, estimates of $\delta_1 - \delta_2$ and $\delta_1 - \delta_3$ will be unbiased (as in a difference-in-differences approach).\(^\text{10}\) As we will also show that $\delta_2 = \delta_3 = 0$, it seems reasonable to believe that our estimate of $\delta_1$ is unbiased.

4. Market and Data

4.1 The market for car repairs

About half of car repair firms are also dealers of a specific car brand (e.g. Mercedes). This makes sense because consumers prefer to have their cars repaired by specialized brand dealers. This is particularly important as it offers car repair firms the option to differentiate themselves (and to seek market power) in two dimensions: location and car brand (Irmen and Thisse, 1998). It can be easily seen that the combination of location and car brand creates a thin supply market and potentially provides suppliers with market power. For example, in the Netherlands, in a representative area with a radius of 30 km (containing a population that owns about 600,000 cars), there are about 500 car repair firms. This seems to suggest fierce competition between repair firms. However, because of the large number of brands (the five most repaired brands represent only 50 percent of all repairs), it appears that in such an area there are, on average, only 10 dealers that are specialised in the same brand.

Brand dealers strongly depend on single car manufacturers in many ways (technical expertise, access to loans, repair parts, see Crandall, 1968). Importantly, in the current context, car manufacturers or their importers may also influence the decision of dealers to open or to close, and where to locate. Given consumer preferences for cars to be repaired by specialised dealers and integrated relations in the car market (Langlois and Robertson, 1989; Masten et al., 1989), car manufacturers may not only have a strong incentive to reduce the local supply of their dealers, but it seems plausible that they are able to reduce supply of dealers. Hence, from a welfare perspective, it is likely that there are too few car dealers (i.e., the distance between dealers is too long).

\(^{10}\) In the recent econometrics literature about difference-in-differences approaches, it is emphasised that it is essential to allow for serial correlation in the error terms (e.g. Wooldridge, 2003). In our context, where we observe two data points over time, this issue does not apply.
Competition within the car repair sector is interesting, not only because of its close link with car manufacturers, that have been shown to have market power already long ago (Kwoka, 1984). For this sector, competition is well-defined, as there are few, and sometimes even no, possibilities to substitute a car repair for economic goods offered by other firms. Another advantage of focusing on car repairs, is that the relationship between distance and transport costs is clearly one-on-one, as consumers have to travel by car in order to get their car repaired (usually they travel twice for one repair). This is particularly important for countries such as the Netherlands, where the majority of shopping trips do not involve any car travel as shoppers use alternative modes such as walking, bicycling and public transport. It also avoids the issue of Internet shopping.

For some small repairs, the consumer may wait several days for the repair. For the majority of repairs, the consumer will receive a car on loan and has to travel twice for one repair. By focusing on car repairs, we also avoid the complication that firms compete with each other based on the supply of (free or subsidized) street parking spaces, typical in the US, or public transport, an important phenomenon in Europe, and we may ignore the complication that firms bundle the supply of certain goods. Information about the location of car repair firms is easy to obtain. As car repair expenditure is non-negligible, it is reasonable to think that many consumers compare prices of car repair firms, particularly because issues such as quality of repair and environmental care are difficult to observe (Schneider, 2012; Mir, 2008). This is in line with studies such as Hubbard (2002) which show that demand for car repairs falls with its price.

4.2 Repair prices data

Our data on repairs for car dealers is obtained from a leasing company in the Netherlands with about 100,000 cars which are repaired, on average, three times a year. When a car is repaired, it usually includes several repair activities (e.g., changing tires and replacing windscreen). Our data refers to the year 2009 (the full 12 months) and 2011 (from January up to mid June). In the

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11 We also have information about 2010, but for this year we do not have information about the number of competitors. We have re-estimated all models including 2010 data, assuming that the number of competitors in 2010 is the same as in 2009. In this case, one expects that due to measurement error, the estimate of the number of competitors is biased towards zero. This is confirmed in the sensitivity analysis where we will
Netherlands, as in most European countries, leasing of cars is attractive because workers realize a substantial income tax advantage when they receive a company car as a fringe benefit from their employer (Gutiérrez-i-Puigarnau and van Ommeren, 2012). So, lease car companies in The Netherlands hardly ever lease directly to consumers, but rather lease to employers who provide the car to employees as a fringe benefit. Hence, in our data, in virtual all cases, the car which is repaired is used by a worker (usually for three years), leased by their employer (also for three years) and owned by the leasing company.

Using data from a car leasing company has several advantages and disadvantages. The main advantage is that we have a standardized dataset with regard to the repairs (e.g. the replacement of a wheel of a Mercedes is coded in the same way for different car repair firms). Furthermore, almost all cars are less than three years old, implying not only that cars are extremely homogeneous with regard to age, but also that standard repair parts and procedures are usually applied.

The main disadvantage is that car repair prices are the prices paid by a commercial firm and not by an individual consumer. This may be a disadvantage when leasing firms have buyer power. This is, however, unlikely to apply because in Europe, in contrast to for example the United States, lease car companies are fairly small and cover only 12 percent of the car market (Gutiérrez-i-Puigarnau and van Ommeren, 2012).

The data analyzed here refers to a firm which covers about 1.5 percent of the total car market. Its share of repairs is much lower though, because lease cars are on average 1.5 years old, whereas other cars are on average six years old. As is well known, new cars have fewer repairs (and much cheaper compared to older cars), so the expenditure share of repairs by this firm will be substantially less than 1 percent.

In our dataset, repairs are categorized into thousands of categories. Price differences between categories tend to be much larger than price differences within categories (e.g., prices of changing the left front tire do vary, but are always less than changing the motor block). For this reason, we focus on six homogeneous categories that represent about half of all repairs: checkups, balancing, repairing breaks, repairing cooling/heating, MOT (safety test) and show that we obtain somewhat lower estimates when we include 2010, but the standard errors are also reduced, and the statistical significance of this effect improves.
repairing/replacing screen wipers. In the analysis, we will estimate separate models for these different categories. Hence, we do not impose that the effect of competition is the same for each type of repair. During 2009 (and 2010), the leasing firm allowed car users to choose their car repair firm from virtually all car repair suppliers in the Netherlands.\[12\] In the year 2011, they restricted the car users' choice set somewhat by excluding the use of a limited number of suppliers (who charged above-market repair prices).

In total we have 235,730 observations of car repairs of which about 70 percent is for the year 2009 (as the period of observation is shorter for 2011).\[13\] In the empirical analysis, we are particularly interested in how prices change per postcode area. We have about 2,000 postcode areas. Table 1 shows that the yearly number of observations per category per postcode area is reasonably high for each category (except for balancing in 2011). The last two columns of this table show that the average price strongly differs between categories, whereas the standard deviations of the prices are rather small, suggesting that the chosen categories are indeed rather homogenous. We do not show the latter descriptive statistics per year as these are almost identical.

<table>
<thead>
<tr>
<th>Type of repair</th>
<th>Total number of observations</th>
<th>Obs. per postcode area: 2009</th>
<th>Obs. per postcode area: 2011</th>
<th>Average price</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Checkup</td>
<td>45,519</td>
<td>31.49</td>
<td>14.06</td>
<td>252.65</td>
<td>73.29</td>
</tr>
<tr>
<td>MOT (Safety test)</td>
<td>28,388</td>
<td>18.93</td>
<td>10.63</td>
<td>48.43</td>
<td>15.44</td>
</tr>
<tr>
<td>Balancing</td>
<td>6,399</td>
<td>8.05</td>
<td>3.32</td>
<td>69.20</td>
<td>18.36</td>
</tr>
<tr>
<td>Breaks</td>
<td>72,548</td>
<td>46.48</td>
<td>22.80</td>
<td>136.53</td>
<td>103.55</td>
</tr>
<tr>
<td>Cooling/heating</td>
<td>29,940</td>
<td>22.58</td>
<td>11.30</td>
<td>103.38</td>
<td>97.47</td>
</tr>
<tr>
<td>Screen wipers</td>
<td>52,936</td>
<td>36.29</td>
<td>18.32</td>
<td>37.80</td>
<td>17.11</td>
</tr>
</tbody>
</table>

Note: Total number of observations is 235,730.

As we have emphasised in the introduction, many car repair firms specialise in one brand. Furthermore, the cost of a repair of a car may depend on brand. Hence, in the analysis, we will not only control for car brand, but the brand of the car also defines our measurement of the type

12 Car repair firms use special software which allows them to accept any arbitrary car from the car leasing companies and to send the repair bill electronically. For large repairs, the car repair firm has to ask permission to the leasing company. After the repair, the leasing company will check the prices paid.

13 To minimize the impact of misreporting, we exclude repairs with a price higher than €500 and lower than €10. Including these outliers has no effect on the results.
of competition. It measures whether other competitors in the neighbourhood of the car repair firm are specialised in the same brand (or other brands) as the car which is repaired. In our data, the five most repaired brands (Ford, Opel, Volkswagen, Renault and Peugeot) represent about half of the total repairs. The 10 most repaired brands represent only 80 percent of all repairs (see Table A1). In our analysis, we will distinguish between 24 car brands.

In addition to the above-mentioned data, we use the address lists of BOVAG, the Dutch industry association for car repair firms, for the years 2009 and 2011.\textsuperscript{14} It represents 2,530 brand dealers and 3,349 independent repair firms, covering 86 percent of the car repair market in terms of firms, but a much higher percentage in terms of turnover. Competition law restricts the association from advising its members about price setting (Beusmans and van Ommeren, 2004). Based on this list, we calculate the number of competitors close to a car repair firm. It appears that there are, on average, about six repair firms per area (see Table 2).

Furthermore, to measure changes in demand for repairs, we use data on the number of cars owned by households per postcode area, provided by the Dutch Bureau of Statistics. Based on the coordinates of the centroid of the 4 digit postcode area, Euclidian distances are calculated. Given these distances, for each repair firm, we calculate the number of cars within 10, 20 and 30 km respectively. Table 2 shows that there are, on average, more than 600,000 cars within 30 km of a repair firm and that the number of cars increases by about 3 to 4 percent in two years.

\textbf{Table 2. Number of repair firms per postcode area and number of cars within a given distance}

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of repair firms</td>
<td>5.97</td>
<td>5.00</td>
<td>1</td>
<td>25</td>
<td>-0.8%</td>
</tr>
<tr>
<td>No. of cars (10 km)</td>
<td>99,492</td>
<td>77,680</td>
<td>3,393</td>
<td>350,250</td>
<td>3.3%</td>
</tr>
<tr>
<td>No. of cars (20 km)</td>
<td>321,850</td>
<td>212,078</td>
<td>6,485</td>
<td>953,630</td>
<td>3.4%</td>
</tr>
<tr>
<td>No. of cars (30 km)</td>
<td>631,090</td>
<td>363,820</td>
<td>35,189</td>
<td>1,496,267</td>
<td>3.7%</td>
</tr>
</tbody>
</table>

In order to measure the effect of the number of competitive repair firms within a radius of 30 km, we use an exponential distance decay function (as explained in section 3). The decay depends on a given parameter $\lambda$. In essence, this weights the number of repair competitors by the distance to the competitor. We will examine a wide range of values of $\lambda$. We will see later on,

\textsuperscript{14} The address list is accurate for 1 May in both years. Clearly, the number of competitors will change within the years, which creates (random) measurement error. So, our estimates will be biased towards zero.
that for the preferred distance-decay specification, \( \lambda \) takes a value of 1/25. This implies that for each additional kilometer, the number of competitors is discounted by 4 percent.

Table 3. Number of competitors within a distance of 30km (with and without distance decay)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Distance decay</td>
<td>No distance decay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Same brand competitors</td>
<td>5.31</td>
<td>3.94</td>
<td>10.37</td>
<td>7.98</td>
</tr>
<tr>
<td>Other brand competitors</td>
<td>107.36</td>
<td>49.97</td>
<td>223.97</td>
<td>98.66</td>
</tr>
<tr>
<td>Generic competitors</td>
<td>124.98</td>
<td>55.42</td>
<td>254.12</td>
<td>112.01</td>
</tr>
<tr>
<td>Total competitors</td>
<td>237.60</td>
<td>105.51</td>
<td>488.47</td>
<td>211.408</td>
</tr>
</tbody>
</table>

Table 3 shows the basic descriptives of the same brand, other brand and generic competitors for the repair firms within a distance of 30 kilometers given distance decay (\( \lambda = 1/25 \)) and when there is no distance decay (\( \lambda = 0 \)). Ignoring distance decay, there are 488 competitors within 30 km, but only 10 of those are specialised in the same brand as the car which is repaired. Given distance decay, there are 237 competitors, but only five of those are specialized in the same brand.

As outlined in section 3, we use a fixed effects approach on the level of postcode areas. This requires that at least some locations change in our study period, either through relocation or through entry and exit. In our data, we have sufficient variation in the change of the number of competitors per area. In only half of the areas there is no change within 30 km. In exactly one quarter of the postcode areas, there is an increase in the number of same brand competitors (within 30 km) and in exactly another quarter, there is a decrease (within 30 km). Given a change in the number of competitors, the mean of the absolute value of the distant-weighted change in the number of same brand competitors is equal to 0.87.

5. Empirical results

5.1 Estimation results

In order to estimate the effect of spatial competition on prices in the car repair industry, we employ a log linear model as indicated above. We distinguish between the effects of the (distance-decay weighted) number of repair firms specialized on the same brand, \( \delta_1 \), the number of repair firms specialized in repairing other brands, \( \delta_2 \), and the number of generic repair firms,
\( \delta_3 \). We estimate separate models for six car repair categories. We are particularly interested in the (weighted) average effect of these separate effects (where the weights are proportional to the number of observations of the different categories). The main results for this specification are provided in Table 4 (assuming that \( \lambda \) takes a value of \( 1/25 \)).

The results below show that the presence of firms, specialized in the same car brand, has a negative effect on the repair prices for four of the categories, of which two are statistically significant at the 5% level. For example, the results suggest that an increase of one (distance-weighted) same-brand firm will induce a reduction of 0.92 percent in the repair price when the cooling/heating system is repaired. It is important to notice that most of these coefficients are not statistically significant due to large standard errors. Importantly, the average effect (reported in the last column) is substantial and statistically significant. This average effect implies that one additional same-brand competitor will induce a decrease of 0.28 percent in the average prices of the repair firm.

Given a one standard deviation increase in the number of same brand competitors (which is about 4), prices of incumbent firms will decrease by about 1 percent. Note that this estimate might be an underestimate if agglomeration effects, which may appear due to the presence of more repair firms, and induce an increase on prices, are present. We emphasise that our results are about the effect of competition on percentage changes in prices, and not about percentage decreases in profits or the rate of return on investment, that are in a larger order of magnitude.

\hspace{1cm}

\[15\text{ As explained above, we control for the (potential) demand for car repairs, measured by the number of cars registered on the zip code area of the repair firm. Additional controls are included like the brand and the mileage of the repaired car and it’s square (in log), the number of repaired parts, type of fuel and 22 dummies that specify a more detailed type of repair to account for heterogeneity within repair categories.} \]

\[16\text{ We provide here clustered standard errors at the postcode level. Arguably, one may cluster at the municipality level (there are 408 municipalities in our data). When we cluster at the level of the municipality, the standard errors of the effect of the number of competitors becomes slightly smaller, whereas the standard error of the effect of the number of cars becomes slightly larger. The opposite occurs when we cluster at the level of the province. In that case, in some specifications, the effect of the number of same-brand competitors is only significant at the 10\% level. Because there are only 12 provinces, the latter level of clustering is clearly too aggregate.} \]
It is important to observe that the effects of generic and other brand repair firms are much smaller in magnitude, and despite much smaller standard errors, the average effect is absent, both for generic as well as for other brand repair firms. In other words, car repair firms have market power, but they are only able to exploit this market power when there are no neighbouring car repair firms that specialise in the same brand. Note that this result not only suggests that the agglomeration effect is quantitatively unimportant, more importantly, it also implies that any bias in the estimate of \( \delta_1 \) is likely negligible.

The impact of other brand firms and generic firms is not significantly different from zero, suggesting that their presence does not constitute a significant competitive pressure on prices. The price elasticity of density (number of cars) can be found directly from the estimates and has a value of 0.87.

### Table 4. Car repair prices

<table>
<thead>
<tr>
<th>Variable</th>
<th>Checkup</th>
<th>MOT (Safety test)</th>
<th>Balancing</th>
<th>Breaks</th>
<th>Cooling/ heating</th>
<th>Screen wipers</th>
<th>Average effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same brand firms</td>
<td>-0.0011 (0.0017)</td>
<td>-0.0059 (0.0036)</td>
<td>0.0039 (0.0036)</td>
<td>0.0008 (0.0028)</td>
<td>-0.0092 (0.0049)*</td>
<td>-0.0047 (0.0023)**</td>
<td>-0.0028 (0.0013)**</td>
</tr>
<tr>
<td>Other brand firms</td>
<td>-0.0010 (0.0012)</td>
<td>-0.0026 (0.0024)</td>
<td>0.0003 (0.0032)</td>
<td>0.0009 (0.0018)</td>
<td>-0.0041 (0.0031)</td>
<td>-0.0001 (0.0014)</td>
<td>-0.0008 (0.0008)</td>
</tr>
<tr>
<td>Generic firms</td>
<td>-0.0008 (0.0007)</td>
<td>-0.0003 (0.0015)</td>
<td>0.0001 (0.0017)</td>
<td>-0.0003 (0.0010)</td>
<td>0.0040 (0.0019)**</td>
<td>-0.0009 (0.0008)**</td>
<td>0.00005 (0.0005)</td>
</tr>
<tr>
<td>Number of cars (in log)</td>
<td>0.7079 (0.4764)</td>
<td>2.7538 (1.2218)**</td>
<td>0.2007 (1.1423)</td>
<td>-0.4012 (0.8259)</td>
<td>2.1303 (1.4986)</td>
<td>1.1061 (0.6021)*</td>
<td>0.8692 (0.3876)**</td>
</tr>
<tr>
<td>Car mileage</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
</tr>
<tr>
<td>Type of repair</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
</tr>
<tr>
<td>Repaired parts</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
</tr>
<tr>
<td>Type of fuel</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
</tr>
<tr>
<td>Brand of car</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
</tr>
<tr>
<td>Year dummy</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
<td>Included</td>
</tr>
<tr>
<td>Number of observations</td>
<td>45,519</td>
<td>28,388</td>
<td>6,399</td>
<td>72,548</td>
<td>29,940</td>
<td>52,936</td>
<td>235,730</td>
</tr>
</tbody>
</table>

Notes: Dependent variable: Price of repair (in log). ** and * indicate that estimates are significantly different from zero at the 0.05 and the 0.10 level, respectively. Clustered standard errors are presented in parentheses.
Recall that proposition 2 states that the elasticity of prices with respect to distance lies between zero and one and is strictly increasing in distance. We will examine this here. Our empirical specification implies that this elasticity is given by:

\[ e_{dist}^p = -\lambda dist \sum_k S_k e^{-\lambda dist_k} \]

The estimated value of \(\delta_1\) is negative and significantly different from zero, implying that the elasticity is indeed increasing in distance. We calculate the value of this elasticity for \(\lambda = 1/25\) and \(dist_{ik} = 5\), for the average value of the distance decay weighted number of firms specialized on the same brand, \(\sum_k S_k e^{-\lambda dist_k}\), which implies that the elasticity is about the same as the negative value of the estimated parameter, \(-\delta_1.17\).

The high value of the price elasticity of density and the low value of the price elasticity with respect to the distance between firms, suggest that the market for car repairs is fairly competitive on average.\(^{18}\) We do note however that in individual cases, especially if no nearby competitors offer repairs for the same brand, local market power may exist.

5.2 Sensitivity analysis

To examine the robustness of these results, we have estimated four other specifications of the model with different values of the distance-decay parameter \(\lambda\) (Table 5) and specifications including 2010 data and with different sets of control variables (Table 6). Table 5 shows that the point estimates do not strongly depend on the exact value of the distance decay parameter. For example, given \(\lambda = 1/9\), which implies that competitors at a distance of 6 km (only a 10 minutes drive) are weighted by about half, or \(\lambda = 0\) (no distance decay), the point estimates are almost equal. Note however that the standard errors become much smaller for smaller values of \(\lambda\) (as for larger values we ignore variation in the number of competitors). Interestingly, the effect of number of cars systematically increases when \(\lambda\) becomes smaller. This not only suggests that demand for repairs comes from a relatively large area, but also that firms realise that consumers may easily switch to competitors within neighbouring municipalities when confronted with local price increases.

\(^{17}\) More precisely, the elasticity equals 0.00297

\(^{18}\) The summed elasticities with respect to distance and density do not differ significantly from unity, implying that the specification correctly replicates our theoretical model.
Table 5 Different distance-decay parameters.

<table>
<thead>
<tr>
<th>Specification</th>
<th>λ=1/9</th>
<th>λ=1/15</th>
<th>λ=1/25</th>
<th>λ=1/90</th>
<th>λ= 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same brand firms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.0021</td>
<td>-0.0029</td>
<td>-0.0028</td>
<td>-0.0022</td>
<td>-0.0019</td>
</tr>
<tr>
<td></td>
<td>(0.0030)</td>
<td>(0.0019)*</td>
<td>(0.0013)**</td>
<td>(0.0007)**</td>
<td>(0.0006)**</td>
</tr>
<tr>
<td>Other brand firms</td>
<td>0.0003</td>
<td>-0.0005</td>
<td>-0.0008</td>
<td>-0.0008</td>
<td>-0.0007</td>
</tr>
<tr>
<td></td>
<td>(0.0017)</td>
<td>(0.0012)</td>
<td>(0.0008)</td>
<td>(0.0005)*</td>
<td>(0.0004)*</td>
</tr>
<tr>
<td>Generic firms</td>
<td>-0.0009</td>
<td>-0.0002</td>
<td>0.00005</td>
<td>0.0001</td>
<td>0.0001</td>
</tr>
<tr>
<td></td>
<td>(0.0011)</td>
<td>(0.0007)</td>
<td>(0.0005)</td>
<td>(0.0003)</td>
<td>(0.0002)</td>
</tr>
<tr>
<td>Number of cars (in log)</td>
<td>0.6562</td>
<td>0.7541</td>
<td>0.8692</td>
<td>0.9874</td>
<td>1.0199</td>
</tr>
<tr>
<td></td>
<td>(0.3409)*</td>
<td>(0.3715)**</td>
<td>(0.3876)**</td>
<td>(0.3928)**</td>
<td>(0.3920)**</td>
</tr>
<tr>
<td>Number of observations</td>
<td>235,730</td>
<td>235,730</td>
<td>235,730</td>
<td>235,730</td>
<td>235,730</td>
</tr>
</tbody>
</table>

Notes: see Table 4. In this specification, we control for the same variables as in Table 4.

Table 6 shows that when the observations from 2010 are included (and using the number of competitors for 2009), we obtain very similar, but more statistically significant, results, see specification (1). As expected, the point estimate is slightly reduced, due to measurement error in 2010, but due to the doubling of the degrees of freedom in this analysis, the standard errors are much reduced. When we do not control for the brand of the car repaired, see (2), or exclude all other control variables, see (3), we obtain stronger effects for the number of same brand firms. Although one may argue that the latter two specifications suffer from omitted-variable bias, it is equally plausible that by controlling for brand of car repaired in the main specification, we partially control for the effect of the number of same-brand firms as the change in the number of same-brand firms and brand of the car are correlated. For example, in our data, the number of Ford dealers is growing. So, by controlling for repairs to a Ford car, we also control for the effect of this nationwide increase.

In specification (4), we allow for the possibility of year-specific province effects. This not only reduces the point estimate, but also increases the standard error of the number of same-brand firms, suggesting that the previous reported results are spurious, for example, because we do not control sufficiently for changes in demand through changes in population. However, when we control for the population of the municipality, see (5), we find a slightly stronger effect than reported before, whereas the standard errors do not increase.19

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19 Note that in this specification, a limited number of observations are excluded because of changes over time in municipalities.
We have also examined the importance of restricting the areas up to 30 km. We are particularly worried for having chosen a too low value. We have re-estimated the model for different values of $\lambda$ (as in Table 5.1). It appears that the standard errors of the effect of the number of same brand firms reduce with the size of the chosen area (for any value of $\lambda$). For example, when we choose the area up to 35 km and $\lambda = 1/90$, the standard error is reduced to 0.0006 (and the estimate is equal to -0.0019). Furthermore, when we increase the size of the area, the point estimates do not change systematically (they may go up or down depending on the value of $\lambda$), but the statistical significance remains the same or improves (for larger values of $\lambda$).

Finally, we have estimated models where we fix the areas size (e.g. to 25 km or to 30 km), but also allow for effects of firms within the next ring of 5 km outside the area. These results show that our conclusions are extremely robust with specification and show that the firms outside the ring do not have a statistically significant effect. Interestingly, we find that the effect of the same brand firms is negative (but with a large standard error), implying that with the current data it is difficult to precisely decide on the geographical scale of the relevant market.
6. Conclusion

We develop and apply a framework capable of estimating the level and intensity of competition with limited data requirements, thus overcoming some of the problems related to the use of traditional indicators to measure competition. Our framework rests on the assumption of a convex cost curve, reflecting short run capacity restrictions. We establish that competitive markets show a strong price response to short term increases in demand, and a weak price response to entry. The intuition behind this is that competitive markets have little room to absorb cost increases, since the price-cost margin is already low. Moreover, the low price-cost margin leaves little room for price responses in case entry occurs.

We apply the framework to micro-data of prices of car repairs, and find an average price elasticity for a change in the demand level of 0.87, as well as a near-zero price elasticity for a change in the distance between firms. This indicates that the market at stake is fairly competitive. Moreover, we find that car repair firms reduce repair prices if the number of local competitors that are specialised in the same car brand increases, but not if the number of other suppliers increases.
Reference list


Appendix

Table A1. Car brands.

<table>
<thead>
<tr>
<th>Brand</th>
<th>Number of obs.</th>
<th>Percentage</th>
<th>Cumulative (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ford</td>
<td>24,586</td>
<td>10.71</td>
<td>10.71</td>
</tr>
<tr>
<td>Opel</td>
<td>23,740</td>
<td>10.34</td>
<td>21.05</td>
</tr>
<tr>
<td>Volkswagen</td>
<td>23,076</td>
<td>10.05</td>
<td>31.10</td>
</tr>
<tr>
<td>Renault</td>
<td>22,771</td>
<td>9.92</td>
<td>41.02</td>
</tr>
<tr>
<td>Peugeot</td>
<td>22,070</td>
<td>9.61</td>
<td>50.63</td>
</tr>
<tr>
<td>Volvo</td>
<td>15,888</td>
<td>6.92</td>
<td>57.55</td>
</tr>
<tr>
<td>Toyota</td>
<td>15,804</td>
<td>6.88</td>
<td>64.43</td>
</tr>
<tr>
<td>Citroen</td>
<td>12,723</td>
<td>5.54</td>
<td>69.97</td>
</tr>
<tr>
<td>Seat</td>
<td>12,477</td>
<td>5.43</td>
<td>75.40</td>
</tr>
<tr>
<td>Audi</td>
<td>10,285</td>
<td>4.48</td>
<td>79.88</td>
</tr>
</tbody>
</table>