

Working paper on entry analysis

4 April 2007

Summary

1. The purpose of this paper is to assess the impact of observed new-store entry on incumbent stores. In particular, we consider how the revenue of incumbent stores responded to the entry of newly-built stores, and how this response varied depending on distance as well as fascia and size of both incumbents and entrants.
2. We find that new-store entry has had a negative impact on revenue for the incumbent store. For example, we estimate that incumbent store revenue has on average decreased by about 4.7% when a new store of similar size entered within a drive-time of 5 minutes. The result is significant both in economic and statistical terms and tends to be realised gradually in the first six to nine months after entry. The estimated responses decrease for more distant entrants, a finding that is consistent with the notion of local competition.
3. There is some variation in the estimated effect of entry on revenue of the incumbent store depending on the fascia and size of both the incumbent and the entrant store. Nevertheless, in almost all cases the incumbent response is strongest for nearby entry and decreases in both economic and statistical significance with increasing distance between incumbent and entrant. We also find that new-store entry by limited assortment discounters Aldi and Lidl has had a negative though often statistically insignificant impact on revenues of nearby incumbent stores of most main fascias.
4. These findings are based on data on incumbent and entrant stores with a net sales area of at least 1,400 sq m, covering most, but not all, main fascias, and entrant stores by limited assortment discounters Aldi and Lidl. We are currently working to extend the analysis to include all main fascias as well as smaller stores.

Introduction

5. The purpose of this paper is to assess the impact of observed new-store entry on incumbent stores. In particular, we look at time series of revenue at the store level to study how the incumbent response to new-store entry varied depending on distance as well as fascia and size of both the incumbent and the entrant store. Based on an analysis of the variation of store performance over time, the results in this paper will inform our assessment of product and geographic market definition and competition. This analysis is complementary to other empirical analyses such as the store margin analysis, which focuses more on variation of store performance across stores and locations.

6. At present, we are only looking at incumbent and entrant stores that can be regarded as suitable for the definition of one-stop shopping adopted in the CC's supermarket investigation in 2000 (ie stores with a net sales area of at least 1,400 sq m, and belonging to all major grocery retailers other than Marks & Spencer and the limited assortment discounters). We also look at new-store entry by limited assortment discounters with stores smaller than 1,400 sq m; more details on our sample of stores are given below. We are currently working to extend the analysis to include all main fascias as well as smaller stores.

7. Our analysis is based on monthly revenue data for incumbent stores for the period from mid-2001 to mid-2006. In particular, we are seeking to understand whether, and by how much, an incumbent store's revenue changes when it is exposed to various kinds of new-store entry. Given the large number of entries as well as a number of contemporaneous effects that we aim to control for (seasonal effects for example), our analysis is regression-based.

Data

8. Based on responses to the Main Party Questionnaire (MPQ), our current analysis covers incumbent stores with a net sales area above (and including) 1,400 sq m of the following fascias: Asda, Morrisons, Sainsbury's, Somerfield, Tesco and Waitrose.¹ Due to missing data on net sales area, we are currently unable to include incumbent stores by [X] but are in the process of following this up.
9. Some stores opened or closed during the period of our sample. Since we aim to identify the entry response of established stores (as opposed to just-opened or soon-to-be-closed stores), we include these stores only from 6 months after their opening date, or until 6 months before their closure date, respectively. In addition, we omit stores whose time series of revenue seems to have gaps.
10. Our main focus is on entry in the form of newly-built stores with a net sales area above (and including) 1,400 sq m.² Our list of newly-built stores is based on data collected by the CC from main parties and includes stores of Asda, Co-op, Morrisons, Sainsbury's, Tesco and Waitrose. There were no newly-built [X] stores with a net sales area above 1,400 sq m. Due to missing data on net sales area, we are currently unable to include newly-built stores by [X] but are in the process of following this up.
11. Drive-time distance between stores is based on a geographic mapping of postcodes provided by CACI using a geographic information system.

¹ For a few stores of these fascias, we are missing data on net sales area. Until we are able to incorporate revised data, we currently use a proxy based on data from other stores of the same fascia. We omit [X] stores of the Tesco Express fascia that, in contrast to all other stores of its fascia, are larger than 1400 sq m.

² Unreported estimation results indicate that other changes in local market structure such as change of fascia or refurbishment at pre-existing retail sites can also negatively affect performance of nearby stores, but the intensity of the response is significantly weaker than for new-store entry.

12. Separately, we also consider entry of newly-built stores by limited assortment discounters Aldi and Lidl, which tend to be smaller than 1,400 sq m.³ [X] did not supply us with sufficient information on new store openings, and we are currently following this up.

Summary statistics

13. The following two Tables provide some summary statistics on the observed extent of new-store entry. Table 1 below gives the number of incumbent stores for which we observe new-store entry within a drive-time of 10 minutes, separately for each observed incumbent and entrant fascia.⁴ For example, [X] sampled stores of the Asda fascia were exposed to entry by new Asda stores within 10 minutes drive-time. It is possible that a store is counted more than once, for example if it has been exposed to entry by various fascias or if it has been repeatedly exposed to entry by stores of the same fascia.

Table 1: Number of store observations with new-store entry (10 min.)

Incumbent stores exposed to entry, by fascia:	Entrant fascia (within 10 minutes drive-time):					
	Asda	Morrisons	Sainsbury	Tesco	Waitrose	Aldi/Lidl
Asda	[X]					
Morrisons						
Sainsbury						
Somerfield						
Tesco						
Waitrose						
Sum						

Note: number of sampled incumbent stores above 1,400 sq m with entry of a new store above 1,400 sq m of the corresponding fascia within 10 minutes drive-time.

14. Table 2 below summarises the net sales area of the entrant store, relative to that of the incumbent store, separately for each observed incumbent and entrant fascia. For

³ Lidl did not provide store-specific data on net sales area, but said that its stores typically have a net sales area between [X] and [X]sqm. We therefore applied the average value of [X] sqm as a proxy for the Lidl stores in list of newly-built stores.

example, newly-built Asda stores within 10 minutes drive-time of incumbent Asda stores were on average [X] times (or [X] %) larger than the incumbent Asda store. On average most new stores of the big four fascias above 1,400 sq m tended to be between 10% and 50% larger than incumbent stores above 1,400 sq m within 10 minutes drive-time.

Table 2: Relative size of entrant stores (10 min.)

Incumbent stores exposed to entry, by fascia:	Entrant fascia (within 10 minutes drive-time):					
	Asda	Morrisons	Sainsbury	Tesco	Waitrose	Aldi/Lidl
Asda	[X]					
Morrisons						
Sainsbury						
Somerfield						
Tesco						
Waitrose						
	Sum					

Note: average net sales area of entrant stores above 1,400 sq m within 10 minutes drive-time, relative to the incumbent store's net sales area. Source: CC analysis.

15. Table 3 summarises the average percentage change in revenue observed for incumbent stores in the month of entry, compared to revenue in the corresponding sales period of the previous year, again separately for each observed incumbent and entrant fascia.⁵ Although basically deseasonalised, these Figures are not corrected for time trends or any other type of contemporaneous effect in the particular month and should therefore be treated with caution. For example, in each month of entry of a newly-built Asda store, revenue by incumbent Asda stores within 10 minutes drive-time increased on average by [X] %, compared to the corresponding sales period in the previous year. The deseasonalised change in monthly revenue cannot be

⁴ [X] newly-built stores above 1,400 sq m of the Co-op fascia are omitted from table 1. They are included in the first set of regressions summarised in table 4 but excluded in the fascia-specific regressions summarised in table 6.

⁵ Some parties have provided revenue data net of VAT whilst others have included VAT, but since we only compare percentage changes in revenue across stores, the results presented here should remain unaffected. Note also that for the period of observation may differ across stores: for most stores, revenue is recorded per calendar month, but for a considerable number it is recorded per 4-week period and thus for altogether 13 periods per calendar year. In our estimations, we have accounted for this difference (see appendix 2 for more details).

calculated for incumbent stores with entry within the first year of the observed revenue data, which leads to missing values for all incumbent [X] stores.

Table 3: Average deseasonalised change in monthly revenue with new-store entry (10 min)

Incumbent stores exposed to entry, by fascia:	Entrant fascia (within 10 minutes drive-time):					
	Asda	Morrisons	Sainsbury	Tesco	Waitrose	Aldi/Lidl
Asda	[X]					
Morrisons						
Sainsbury's						
Somerfield						
Tesco						
Waitrose						

Note: average percent change in revenue for incumbent stores in the month of entry, compared to revenue in the corresponding sales period of the previous year. Figures are not corrected for any other type of contemporaneous effect. Source: CC analysis.

16. In addition, a focus on the particular month of entry does not account for any revenue or other strategic response to entry that may have occurred after of before entry. Within a regression approach, as we employ below, it is possible to separate a potential revenue response to entry more precisely from contemporaneous effects such as seasonality, fascia-wide promotions or changes in store characteristics, and to understand better how this response is distributed around the actual entry date.

Estimation results

17. Our regressions relate the change in the incumbent store's revenue over time to various measures of entry.⁶ The following results are mainly based on a quarterly aggregate of monthly revenues; estimations based on monthly data yield similar results. All regressions include dummy variables that capture quarter-specific (seasonal) effects for each of 9 fascias as well as a potential trend in revenue growth for each of 12 UK regions (see appendix 2 for more details on the specification). In

⁶ We use the difference in the natural logarithm of revenue as our measure for the change of store performance, because it can be derived directly from a standard empirical model (see appendix 2 for more details).

other words, we isolate the incumbent's revenue response to entry from a regional time trend in revenue growth and contemporaneous average revenue growth at the fascia-level, which captures fascia-specific seasonal effects but also the effect of fascia-wide promotions in the particular quarter or month.

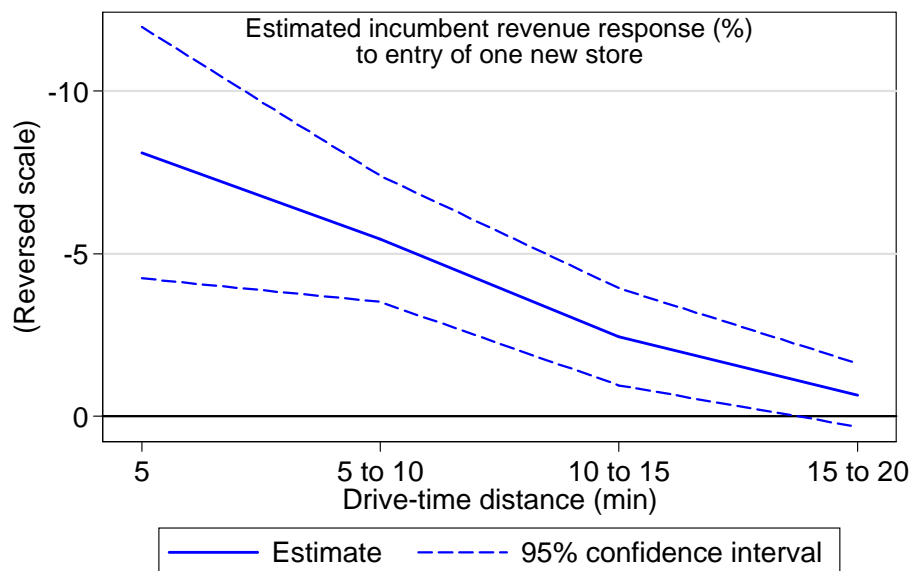
18. It is important to note, however, that our estimates of the incumbent response do not account for a potentially endogenous relationship between revenue growth and new-store entry. On the one hand, unobserved factors such as local demand shocks may simultaneously drive both new-store entry and incumbent revenue growth. On the other hand, presumably every observation of new-store entry is the result of strategic behaviour by both entrant and incumbent (as opposed to a random "entry experiment"). Therefore, our estimates cannot be interpreted as accurate predictions of the revenue response in a counterfactual case of entry (ie one we do not observe). In appendix 2, we argue that, if significant, the corresponding estimation bias is likely to lead us to understate the competitive impact of new-store entry.

19. All regressions include dummy variables that capture the revenue effect of own-store refurbishment for the two quarters or six months following refurbishment. We only consider refurbishments that cost £500,000 or more. In theory, own-store refurbishment may also be a strategic incumbent response to entry; however, allowing for the fact that both refurbishments and new-store openings may follow seasonal patterns,⁷ we found little additional evidence that own-store refurbishment has been associated with nearby entry of new stores. We also found no evidence that incumbent stores for which we observe the number of promotions increase promotional activity as a response to new-store entry.

⁷ Entry tends to concentrate close to seasonal highpoints at the end of the calendar year.

20. Figure 1 below plots the estimated incumbent revenue response to new-store entry with increasing drive-time distance between incumbent and entrant. For these estimates, new-store entry is comprehensively measured by a store count, without accounting for size differences between stores nor differences between fascia. With an average decrease in revenues of about 8%, the estimated average incumbent response is strongest for nearby entry of a new store within a drive-time of 5 minutes and decreases for more distant entry. The dashed lines in Figure 1 represent the 95% confidence interval for the estimates, which are indicative of the variation in revenue responses in the data. For example, they indicate that most observed individual revenue responses to new-store entry within 5 to 10 minutes drive-time tended to lie between -7% and -4%. The estimated revenue response to entry of one new store within 15 to 20 minutes drive-time is slightly negative on average, but its 95% confidence interval also includes zero and positive responses.

Figure 1: Estimated revenue response to entry of one new store above 1,400 sq m



Note: Using data for stores with net sales area of 1,400 sq m or more. Estimates assume that seasonal effects are neutral to entry effect.

21. The response estimates shown in Figure 1 above are calculated from regression results based on quarterly variation in store revenues. The first column of Table 4 below presents the corresponding parameter estimates. To allow for the possibility that an incumbent's revenue may respond gradually to new-store entry, all regressions include lags of the entry measure. With quarterly revenue data, we are estimating a revenue response to entry in the quarter in which entry occurred as well as in the two subsequent quarters.
22. Interpretation of the regression coefficients in Table 4 is as follows: A coefficient of -.022 in column (I) of Table 3 for "Revenue change in quarter of entry" within 5 to 10 minutes drive-time indicates that on average, an incumbent store's revenue is estimated to have decreased by 2.2% in the quarter in which a new store entered within a drive-time of 5 to 10 minutes. The coefficient beneath of -.027 in column (I) of Table 4 for "Revenue change in quarter after entry" indicates that on average, an incumbent store's revenue is estimated to then have decreased by *another* 2.7% in the quarter following entry of a new store within a drive-time of 5 to 10 minutes. Interpretation is along the same lines for "Revenue change in 2nd quarter after entry" and for the other three classes of distance to entrant. The combination of the estimated quarterly responses then provides an estimate for the medium-term incumbent response to entry – as opposed to a long-term response, which may consist, for example, of store repositioning or closure. A numerical example below illustrates how these estimates add up to a persistent revenue loss in response to entry and how seasonal variation can confound the effect.⁸

⁸ The estimates shown in Figure 1 above of the overall incumbent response are computed under the assumption that eventual seasonal effects are neutral to the response to entry. More details on computation of the estimated overall response can be found in appendix 2.

Table 4: Regression results for comprehensive measures of entry

Estimated quarterly revenue response to entry, where entry is measured by	(I) Increase in the number of newly- built stores above 1,400 sq m	(II) Increase in the sales area of newly-built stores above 1,400 sq m, relative to the incumbent store
<i>Entry within 5 minutes drive-time:</i>		
Revenue change in quarter of entry	-.047 ^{***}	-.027 ^{***}
Revenue change in quarter after entry	-.038 ^{***}	-.025 ^{***}
Revenue change in 2 nd quarter after entry	.0024	.0042
<i>Entry within 5 to 10 minutes drive-time:</i>		
Revenue change in quarter of entry	-.022 ^{***}	-.019 ^{***}
Revenue change in quarter after entry	-.027 ^{***}	-.015 ^{***}
Revenue change in 2 nd quarter after entry	-.0064	-.0063 ^{**}
<i>Entry within 10 to 15 minutes drive-time:</i>		
Revenue change in quarter of entry	-.0014	-.0044 [*]
Revenue change in quarter after entry	-.018 ^{***}	-.011 ^{***}
Revenue change in 2 nd quarter after entry	-.0056	-.0027
<i>Entry within 15 to 20 minutes drive-time:</i>		
Revenue change in quarter of entry	.0057 [*]	.002
Revenue change in quarter after entry	-.0028	-.0013
Revenue change in 2 nd quarter after entry	-.0094 ^{***}	-.0044 ^{***}
<i>Own-store refurbishment:</i>		
Revenue change in quarter of refurbishment	-.017 ^{***}	-.017 ^{***}
Revenue change in quarter after refurbishment	.026 ^{***}	.026 ^{***}
Revenue change in 2 nd quarter after refurbishment	.0031	.003
Store-quarter observations	22057	22057
Adjusted R-squared	0.343	0.343

Note: All regressions include 12 region and 160 fascia-quarter dummies.
Stars indicate that coefficients are significantly different from zero with the following confidence levels: * 90%; ** 95%; *** 99% (the corresponding standard errors are robust to heteroskedasticity and autocorrelation of unknown form). Source: CC analysis.

23. A coefficient of -.017 in column (I) of Table 4 for “Revenue change in quarter of refurbishment” indicates that on average, store refurbishment has led to an decrease in revenue by 1.7% in the quarter of refurbishment, which is consistent with the fact that stores often have to close for some time while they are being refurbished.⁹ Refurbishment is associated with additional revenue growth in subsequent quarters, however, and the estimated medium-term revenue response to own-store refurbishment, a combination of the two lag refurbishment coefficients, is 2.9%. We

⁹ Note, however, that by omitting stores with gaps in their revenue time series we effectively remove all stores with a refurbishment-related closure of more than one month from our estimation sample.

use this estimate as a comparison Figure to evaluate the economic significance of the estimated revenue responses to entry.

24. The estimates in column (I) do not account for size differences between the entrant and the incumbent store but are simply based on whether a new store entered without distinguishing the type of entry by these other factors. Column (II) of Table 4 presents estimates based on a more precise measure of entry, which we will be using in all further estimations: the net sales area of the entrant store(s) within a given drive-time of the observed incumbent, relative to the incumbent's net sales area. For example, if, in the given quarter, the observed store was subject to entry by one or more stores that altogether were twice as large as the incumbent store, then the value of the coefficient that expresses the impact of this entry would be multiplied by two. That is, a coefficient of $-.027$ in column (II) of Table 4 for the contemporaneous value of entry within 5 minutes drive-time ("Revenue change in quarter of entry") indicates that on average, an incumbent store's revenue is estimated to have decreased by about 5.4% in the quarter of nearby entry of a new store with twice as much net sales area.
25. Two numerical examples in Table 5 below show how the estimated quarterly incumbent revenue response to entry of a newly-built store with equal net sales area within 5 to 10 minutes drive-time (column (II) of Table 4) add up to medium-term revenue losses. The first example includes a positive trend in revenue growth as well as a varying seasonal effect, whereas the second example includes only an entry effect. In the second case the medium-term revenue loss adds up to 4.0%, whereas in the first example the seasonal effects slightly accentuate it, to a total of 4.1%. Therefore, when calculating estimated medium-term revenue responses such as those presented in Figure 1 above we do not include any seasonal effects, which is

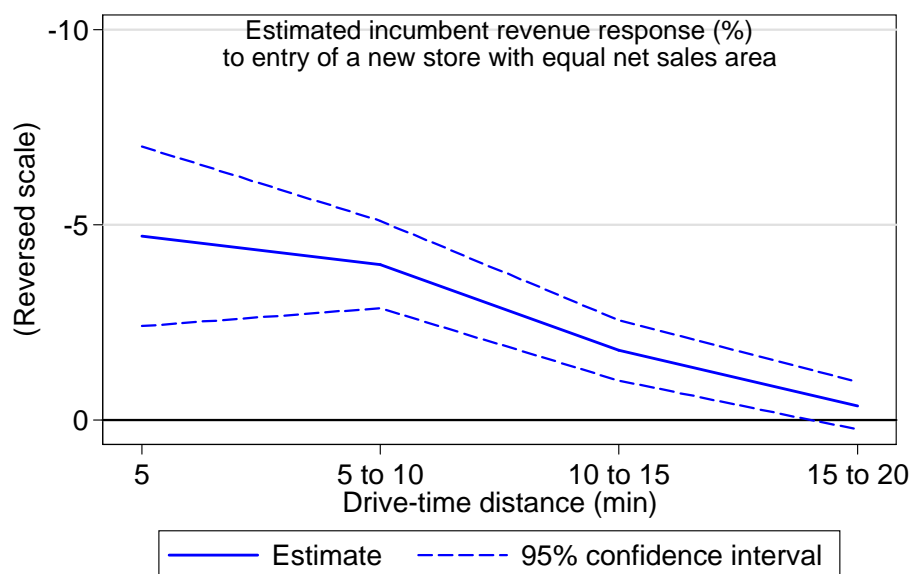
equivalent to assuming that seasonal effects are on average neutral to the entry effect.

Table 5: Numerical examples for the medium-term impact of new-store entry

Quarter	Region trend in revenue	Seasonal effect	Revenue without entry	Entry effect on quarterly growth rate	Revenue with entry	Difference	Percent difference
<i>Example 1:</i>							
Q1 (with entry)	0.5%	-10.0%	905,000	-1.9%	886,000	-19,000	-2.1%
Q2	0.5%	4.0%	945,725	-1.5%	912,580	-33,145	-3.5%
Q3	0.5%	-4.0%	912,625	-0.6%	874,890	-37,734	-4.1%
Q4	0.5%	10.0%	1,008,450	0.0%	966,754	-41,696	-4.1%
<i>Example 2:</i>							
Q1 (with entry)	0.0%	0.0%	1,000,000	-1.9%	981,000	-19,000	-1.9%
Q2	0.0%	0.0%	1,000,000	-1.5%	966,285	-33,715	-3.4%
Q3	0.0%	0.0%	1,000,000	-0.6%	960,197	-39,803	-4.0%
Q4	0.0%	0.0%	1,000,000	0.0%	960,197	-39,803	-4.0%
Note: "Entry effect on quarterly growth rate" as implied by coefficient estimates for the revenue response to new-store entry of equal store size within 5 to 10 minutes drive-time (Table 4, column (II)). Source: CC analysis.							

26. Based on the coefficients in column (II) in Table 3 above and for the case when the entrant has the same net sales area as the incumbent, Figure 2 plots the estimated medium-term incumbent revenue response. New-store entry of equal size within 5 minutes drive-time is estimated to have led to a decline in incumbent store revenue of 4.7% on average and in the medium term. Estimates decrease in absolute value with increasing distance.

Figure 2: Estimated revenue response to entry of a new store of equal size



Note: Using data for stores with net sales area of 1,400 sq m or more. Estimates assume that seasonal effects are neutral to entry effect.

27. Altogether, the estimates in Table 3 and Figures 1 and 2 suggest that on average and across all observed fascia, new-store entry has had a negative impact on revenue for the incumbent stores. Incumbent revenue declined gradually after new-store entry; the medium-term decline was on average stronger for nearby entry and weaker for more distant entrants, a finding that is consistent with the notion of local competition. In comparison with the revenue increase following a store's refurbishment, which estimate at about 2.9% for refurbishments that cost at least £500,000, statistically significant estimates of 4% to 5% revenue decline in response to entry also appear to be economically significant.

Fascia-specific estimates

28. The following Figures present fascia-specific estimates of the medium-term revenue response to new-store entry. They are based on regressions which are similar to those described above but are estimated separately for each main fascia while allowing the incumbent response to vary depending on the entrant fascia (including smaller stores of Aldi and Lidl).¹⁰ In addition, we only distinguish between two bands of distance to entrant (up to 10 minutes and between 10 and 20 minutes drive-time). This is due to the low number of entry observations in certain pairs of incumbent-entrant fascia, a fact that should also be kept in mind when interpreting the corresponding estimates. Therefore, the following Figures also provide the number of observed incumbent stores with new-store entry of each of the main fascia within each distance band.¹¹ Table 6 in appendix 1 lists the regression coefficients that underlie the medium-term response estimates presented in Figures 3 to 8.

¹⁰ As the estimates account for the relative differences in store size between incumbent and entrant, we do not distinguish between the different Tesco fascias.

¹¹ Due to occasionally missing revenue data, for some fascia the number of observed incumbent stores with entry decreases compared to the numbers reported in table 1.

29. Figure 3 below plots the estimated medium-term revenue response of incumbent stores of the [Firm A] fascia for the case of new-store entry of equal size for each of the big four fascia. Estimates are negative and statistically significant for nearby entry of new stores by all fascia except [Firm D]. For example, we estimate that revenue of an [Firm A] incumbent store has declined by about 5.8%, on average and in the medium term, when an equally large new [Firm E] store entered within 10 minutes drive-time. This estimate is based on [X] [Firm A] stores for which we observe [Firm E] new-store entry within 10 minutes drive-time.

Figure 3: Estimated revenue response by incumbent stores of the [Firm A] fascia

[X]

30. Figure 4 below plots the estimated medium-term revenue response of incumbent stores of the [Firm B] fascia for the case of new-store entry of equal size for each of the big four fascia. Estimates are negative for nearby entry of new stores by all fascia (statistically significant for all except [Firm B]). For example, we estimate that revenue of a [Firm B] incumbent store has declined by about 6.4%, on average and in the medium term, when an equally large new [Firm A] store entered within 10 minutes drive-time. This estimate is based on [✂] [Firm B] stores for which we observe [Firm A] new-store entry within 10 minutes drive-time.

Figure 4: Estimated revenue response by incumbent stores of the [Firm B] fascia

[✂]

31. Figure 5 below plots the estimated medium-term revenue response of incumbent stores of the [Firm C] fascia for the case of new-store entry of equal size for each of the big four fascia. There was no entry of a newly-built [Firm A] or [Firm B] store above 1,400 sq m within 10 minutes drive-time of incumbent [Firm C] stores above 1,400 sq m. Response estimates are negative for nearby entry of new stores by [Firm D] and [Firm E] but statistically significant only for [Firm E] entry. We estimate that revenue of a [Firm C] incumbent store has declined by about 7.8%, on average and in the medium term, when an equally large new [Firm E] store entered within 10 minutes drive-time. This estimate, however, is based on only [✂]
32. [Firm C] stores for which we observe [Firm E] new-store entry within 10 minutes drive-time.

Figure 5: Estimated revenue response by incumbent stores of the [Firm C] fascia

[✂]

33. Figure 6 below plots the estimated medium-term revenue response of incumbent stores of the [Firm D] fascia for the case of new-store entry of equal size for each of the big four fascia. Estimates are negative for nearby entry of new stores by all fascia (statistically significant for all except [Firm A]). For example, we estimate that revenue of a [Firm D] incumbent store has declined by about 6.3%, on average and in the medium term, when an equally large new [Firm E] store entered within 10 minutes drive-time. This estimate is based on [✂] [Firm D] stores for which we observe [Firm E] new-store entry within 10 minutes drive-time.

Figure 6: Estimated revenue response by incumbent stores of the [Firm D] fascia

[✂]

34. Figure 7 below plots the estimated medium-term revenue response of incumbent stores of the [Firm E] fascia for the case of new-store entry of equal size for each of the big four fascia. Estimates are negative for nearby entry of new stores by all fascia (statistically significant for all except [Firm D]). For example, we estimate that revenue of a [Firm E] incumbent store has declined by about 2.7%, on average and in the medium term, when an equally large new [Firm A] store entered within 10 minutes drive-time. This estimate is based on [✂] [Firm E] stores for which we observe [Firm A] new-store entry within 10 minutes drive-time.

Figure 7: Estimated revenue response by incumbent stores of the [Firm E] fascia

[✂]

35. We also looked at the revenue responses of stores above 1,400 sq m to entry by Aldi and Lidl. Figure 8 below plots the estimated medium-term revenue response new-store entry of Aldi and Lidl for each of the big four fascia and with increasing distance and for the case that the net sales area of the entrant is one fourth of the incumbent's net sales area (which corresponds roughly to the Figures in Table 2). The estimated response is negative for entry nearby incumbent stores of the [Firm B], [Firm D] and [Firm E] fascia but significantly different from zero only for incumbent stores of [Firm B]. We estimate that revenue of a [Firm B] incumbent store has declined by about 3%, on average and in the medium term, when a new Aldi or Lidl store with one quarter of the incumbent's net sales area entered within 10 minutes drive-time. This estimate is based on [✂] [Firm B] stores for which we observe Aldi or Lidl new-store entry within 10 minutes drive-time.

Figure 8: Estimated revenue responses to Aldi or Lidl new-store entry

[✂]

Appendix 1: Fascia-specific regression results

Table 6: Fascia-specific regression results

Quarterly revenue response to entry, estimated separately by incumbent fascia, where entry is measured by the increase in the sales area of newly-built stores above 1,400 sq m, relative to the incumbent store	[Firm A] incumbent stores	[Firm B] incumbent stores	[Firm C] incumbent stores	[Firm D] incumbent stores	[Firm E] incumbent stores
<hr/>					
[Firm A] entry within 10 minutes drive-time:					
Revenue change in quarter of entry		[✂]			
Revenue change in quarter after entry					
Revenue change in 2 nd quarter after entry					
[Firm A] entry within 10 to 20 minutes drive-time:					
Revenue change in quarter of entry					
Revenue change in quarter after entry					
Revenue change in 2 nd quarter after entry					
[Firm B] entry within 10 minutes drive-time:					
Revenue change in quarter of entry					
Revenue change in quarter after entry					
Revenue change in 2 nd quarter after entry					
[Firm B] entry within 10 to 20 minutes drive-time:					
Revenue change in quarter of entry					
Revenue change in quarter after entry					
Revenue change in 2 nd quarter after entry					

[Firm C] entry within 10 minutes drive-time:

Revenue change in quarter of entry
Revenue change in quarter after entry
Revenue change in 2nd quarter after entry

[✂]

[Firm C] entry within 10 to 20 minutes drive-time:

Revenue change in quarter of entry
Revenue change in quarter after entry
Revenue change in 2nd quarter after entry

[Firm D] entry within 10 minutes drive-time:

Revenue change in quarter of entry
Revenue change in quarter after entry
Revenue change in 2nd quarter after entry

[Firm D] entry within 10 to 20 minutes drive-time:

Revenue change in quarter of entry
Revenue change in quarter after entry
Revenue change in 2nd quarter after entry

[Firm E] entry within 10 minutes drive-time:

Revenue change in quarter of entry
Revenue change in quarter after entry
Revenue change in 2nd quarter after entry

[Firm E] entry within 10 to 20 minutes drive-time:

Revenue change in quarter of entry
Revenue change in quarter after entry
Revenue change in 2nd quarter after entry

Aldi/Lidl entry within 10 minutes drive-time:

Revenue change in quarter of entry
Revenue change in quarter after entry
Revenue change in 2nd quarter after entry

Aldi/Lidl entry within 10 to 20 minutes drive-time:

Revenue change in quarter of entry
Revenue change in quarter after entry
Revenue change in 2nd quarter after entry

Revenue change in quarter of own-store refurbishment

Revenue change in quarter after own-store refurb.

Revenue change in 2nd quarter after own-store refurb.

Store-quarter observations

Adjusted R-squared

Note: All regressions include 12 region and 160 fascia-quarter dummies. Stars indicate that coefficients are significantly different from zero with the following confidence levels: * 90%; ** 95%; *** 99% (the corresponding standard errors are robust to heteroskedasticity and autocorrelation of unknown form). Source: CC analysis.

Appendix 2: Estimation method

36. Our performance measure to assess the effect of new-store entry on incumbent stores is revenue. Clearly, revenue of a store depends on a number of factors including store characteristics (such as net sales area and PQRS), local demand factors (such as mean household income), fascia characteristics (such as the quality of own-label products and fascia-wide promotions), as well as seasonal effects (such as the Christmas effect). A standard functional form for an empirical analysis of this dependence is the semi-logarithmic form:

$$(1) \quad \log(R_{ifgt}) = x_{1,i}\beta_1 + x_{2,it}\beta_2 + x_{3,gt}\beta_3 + x_{4,ft}\beta_4 + \varepsilon_{ifgt},$$

where the dependent variable is the natural logarithm of store i 's revenue in period t , the β s are parameters to be estimated, $x_{1,i}$ contains time-invariant characteristics of store i and local demand around store i (including a store-specific constant term), $x_{2,it}$ contains time-variant store characteristics (including measures of local competition around store i), $x_{3,gt}$ and $x_{4,ft}$ contain time-variant effects (including seasonal effects) at the region- and fascia-level. We account for the corresponding effects with a collection of dummy variables.

37. By looking at first differences in store performance, we can implicitly account for time-invariant store and demand characteristics while focusing on inter-temporal dynamics (where Δz denotes first-differences of variable z):

$$(2) \quad \Delta \log(R_{ifgt}) = \Delta x_{2,it}\beta_2 + \Delta x_{3,gt}\beta_3 + \Delta x_{4,ft}\beta_4 + \Delta \varepsilon_{ifgt}$$

38. For example, if $x_{2,it}$ contains information on market structure around store i (say, the number of stores above 1,400 sq m within 10 minutes drive-time), then coefficient β_2 gives the estimated change in revenues associated with the entry of an additional

store above 1,400 sq m within 10 minutes drive-time. If $x_{2,it}$ *only* contains information on entry of a certain type, then coefficient β_2 can be interpreted as a difference-in-differences estimator, where the control group of stores is defined by $\Delta x_{3,gt}$ and $\Delta x_{4,ft}$. However, $x_{2,it}$ may in addition contain information on store characteristics that change over time. In particular, the date at which a store has been refurbished marks a discrete change in store characteristics that we aim to account for in estimation. Store-specific time-variant data on opening hours, promotions and product range may be used as well, but these data are available only for a limited number of stores.

39. To allow for the possibility that incumbent revenue responds gradually to entry, all regressions include lagged values of the corresponding entry variable. The medium-term revenue response to entry can then be derived from a combination of the estimated coefficients for all employed lags. For example, a regression with two lagged values of $\Delta x_{2,it}$ gives three coefficients: one for the contemporaneous effect ($b_{2,L0}$) and two for the lagged effects ($b_{2,L1}$; $b_{2,L2}$). For the case that seasonal or any other contemporaneous effects are zero or neutral to the entry effect (see Table 5 for an example where seasonal effects aggravate the entry effect), the estimate for the medium-term effect can be calculated as $(1 + b_{2,L0}) * (1 + b_{2,L1}) * (1 + b_{2,L2}) - 1$. This being a nonlinear combination of regression coefficients, the standard error of this estimate can be calculated using the delta method (see Wooldridge (2002), *Econometric Analysis of Cross Section and Panel Data*, pp. 44f).

40. Our preferred specification for the seasonal effects is a time-specific revenue change that is common to all stores of fascia f , which may be due, for example, to fascia-wide changes in PQRS but it may also capture fascia-specific seasonal effects ($\Delta x_{ft}^4 = \lambda_{ft}$). We also allow for a time trend in revenue growth common to all stores in region g

($\Delta x_{gt}^3 = \lambda_g$), which, for example, proxies for demographic changes in region g .¹² In other words, when estimating the average revenue response to entry at the store-level, we correct for contemporaneous average revenue growth at the fascia-level as well as a regional time trend in revenue growth.

41. Notice that equations (1) and (2) imply different specifications of the regression error. For the estimation results presented above, we assume that entry is exogenous to the change in revenue around the entry date ($E[\Delta \varepsilon_{it}|X]=0$). Our estimates would be biased if there was an unobserved factor that is not accounted for by any of the variables in X and that simultaneously affects new-store entry and the revenue dynamics of the incumbent stores. For example, there may be anticipated demand growth at a narrow local level that differs significantly from regional growth and leads to local new-store entry. In this case, our negative estimates for the revenue response to entry would carry an upward bias. Since we are looking at new-store entry only (and not at store exit), we believe that if significant a potential endogeneity bias in our estimates is likely to be positive, which implies that our negative estimates of the incumbent revenue response to new-store entry are conservative. In other words, accounting for a potential endogeneity bias, the actual revenue response to new-store entry is likely to be more intense than implied by our estimates.

42. Another source of endogeneity bias is the fact that every observation of new-store entry and incumbent response is likely to be the result of strategic behaviour by both entrant and incumbent (as opposed to a random “entry experiment”). Therefore, our estimates cannot be interpreted as accurate predictions of the revenue response in a counterfactual case of entry (ie one we do not observe). In particular, if there are cases in which strategic incumbent behaviour successfully deterred profitable entry,

¹² A more flexible specification that allows for a time-specific regional effect has the disadvantage that it is very likely to pick up some of the entry effect, as entrant stores do not feed into estimation of the regional effect (for incumbent stores that opened or

then incumbent stores without observed entry would be a biased control group in estimation and our estimates would understate the general impact of new-store entry.

43. In our dataset, the periods of observation differ across stores: for most stores, revenue is recorded per calendar month, but for a considerable number it is recorded per 4-week period and thus for altogether 13 periods per calendar year. Since we look at first differences in the log of revenue, estimation results should not be affected by the fact that observed revenue periods differ slightly across stores (as long as the length of revenue periods does not change at any time for a given store). Yet, since the stores with 4-weekly recorded revenue have one more revenue observation per calendar year, in regressions two of these observations, or two of the aggregated 3-period (quarterly) observations, may be attributed to the same dummy variable for calendar month or quarter. We account for any implied artificial effects with additional month- or quarter-specific dummy variables that take the value one whenever two subsequent revenue observations are attributed to the same fascia-month or fascia-quarter dummy.

closed during the period of our sample, we omit revenue observations within 6 months of the opening or closure date).