A list of responses to the reviewers' comments

We would like to thank the two anonymous reviewers for their helpful comments and valuable suggestions. We have carefully read through the report and revised the manuscript by taking into account all the comments. We believe that the paper has improved substantially with their contributions.

In addition to the modifications based on the reviewers’ suggestions, we highlight the following major changes in the revised manuscript:

1. We now modify the models to capture the seasonal effect using trigonometric variables, and we re-run the entire analysis. We find that all the results are consistent. Also, the models now generate more accurate forecasts compared to the previous models which capture the seasonal effect using deterministic four-week dummy variables. We thank the reviewer’ helpful suggestions.
2. We now reorganize the literature review section and critically review those previous forecasting studies by highlighting their limitations.
3. We clarify and improve the Tables by adding captions and revising their formats.
4. We make clear that the Base-lift method is not the industrial standard and some retailers are taking advantages of econometric models.
5. We briefly summarize the intuition we found in section 8 in the previous draft and we put it to the last section. We make it clear that the results are exploratory and we leave further analysis to future research.
6. We have carefully proofread the manuscript and have in that respect asked a professional proofreading editor to help us with the task.

Please see our detailed responses to the reviewers’ comments as follows:

Reviewer comments:

Reviewer #1: I am not very happy with the authors' response to my criticism of their use of 12 four-week dummies to capture seasonality. First, they note that this parameterization assumes the seasonal effect to be constant \*within\* each four-week bucket, which is good - but they do not seem to note the other effect I noted: that in this parameterization, \*different\* four-week buckets are treated as \*completely unrelated\*. This parameterization assumes that there is no reason why June and July should be any more similar than June and December, which is prima facie ecologically very doubtful. Also, they claim in their response that "the models are estimated with a comparably large sample (e.g., 160 weeks), where the loss of 12 degrees of freedom is not an issue". First, 12 df are indeed a problem for models with just 160 observations. A good rule of thumb is having 20 observations per df, and here we have about 15. But we actually have far fewer than 15 observations per df!

The truly monumental four-line equation (7) alone seems to imply 52 dfs if we consider only a single interacting product (M=N=P=1). The entire system is hopelessly overparameterized, and no, using the Lasso does not mean that an ecologically invalid parameterization (see above) suddenly becomes ecologically valid.

I would definitely suggest that the entire analysis be re-run with a far more parsimonious and ecologically valid seasonal model. However, this would be a lot of work, and I believe that the paper is useful even with the current seasonal model. Nevertheless, I do not want readers to come away with the impression that this approach is defensible. (It isn't. There is no argument in favor, except for "we already did it this way", and that it is easy to interpret - but so is the humour theory in medicine.) Consequently, the least I urge is a \*much\* stronger statement about the limitations of the seasonal model.

We thank the reviewer for pointing out the limitation of the four-week dummy variables and the potential benefit of the trigonometric variables in capturing the seasonal effect. We have taken this on board and we realize that this is an important suggestion and therefore we have conducted the entire analysis using trigonometric variables to account for the seasonal effect. The results are all consistent with the results which we have obtained in the previous submissions of the paper and do not change the main contributions of the paper. We find that the models with trigonometric variables do have higher forecasting accuracy compared to the models that provided earlier where we capture the seasonal effects using deterministic four-week dummy variables. We thank the reviewer for the suggestion which is indeed helpful.

Section 2, the literature review, should be revisited. Section 2.1 is one long paragraph. Please break it up and structure paragraphs logically. Section 2.2 is entitled "The effect of marketing activities including price and promotions", but all of section 2.1 is already about promotional modelling. Please reorganize. In addition, please critically review the literature cited and consider cutting literature that does not consider \*forecasting\*.

Following your suggestion, we now reorganize section 2.1 into two paragraphs: the first paragraph introduces the studies which deal with the problem of forecasting retailer product sales for the promoted period and the non-promoted period separately; the second paragraph introduces the studies which do not split the forecast period.

We also revise section 2.2 to highlight evidence from previous studies which suggests that the effects of marketing activities are likely to change over time thus justifying the need for the main contribution of our research. We now shorten the review of the studies which focus on previously well-known effects of the marketing activities.

We also provide a more critical review of previous studies by highlighting their limitations in relation to our research contributions.

Eqs. 12 & 13: since all the MASEs have the same denominator, the formulas can equivalently be written in terms of MAEs, which may be a bit more intuitive.

We thank the reviewer for pointing this out. We now add a note “In Equation (12) and (13), all the MASE’s have the same denominator, thus the percentage reductions of the MASE is equivalent to the percentage reductions of the MAE”.

Table 6: please indicate in the table caption that positive numbers refer to forecast improvements with respect to the benchmark (same for Figure 3). By which logic are entries bolded?

Revised: we have added notes to indicate that positive numbers refer to forecast improvement.

We now remove the bolded format in Table 6. Instead, we explain the logic of why we select the product categories and show their results in Figure 3(a) and 3(b). e.g., “Figures 3(a) and 3(b) show the boxplots for the percentage reduction in the MASE for selective product categories where the two methods respectively produce the greatest improvement in forecasting performance compared to the ADL-intra model.”

Here is another possible explanation for structural changes in response to markting activities: the IRI dataset spans four years. It is quite possible that promotions have changed during this time, even if they are all labeled "feature" and "display". For instance, display racks may have been redesigned, or features moved from weekly flyers to mobile apps. (Condensing the enormous amount of different promotions at a typical retailer into just two categories "feature" and "display" is a bit of a laugh, too, but that is a feature of the IRI dataset.)

We thank the reviewer for highlighting this point. We add this in section 2.2 as one of the reasons marketing activities may change. In particular, we add the following sentence:

“The effect of the marketing activities can also change depending on how retailers communicate their marketing events. For example, retailers may promote products through mobile applications and adopt new prominent promotional shelf tags, which can make promotions more effective (Dinner, Heerde, & Neslin, 2015). The effect of the marketing activities can also change due to an update of their content and format. For example, retailers tend to launch promotional events of a wide range of types such as multi-buy promotions, store flyers, mobile apps, billboard advertising, and temporary price reduction (TPR), or TPR for shopper-card holders only. Retailers may initially promote a product with ‘Buy One Get One Free’ but then update the content to ‘Buy One Get the Second for Half Price” months later. They may change the format of the feature advertising from weekly store flyers to mobile apps and also redesign the racks of their display. These changes in the content and format of marketing activities can be expected to lead to changes in consumer response.”

The authors keep referring to the base-lift method as the industry standard. I beg to differ. There are lots of econometric methods (see section 5.3 in Fildes et al., 2018), which should definitely outperform base-lift. In particular since the authors' description of base-lift implies that the lift factor is taken from the last promotion, regardless of whether it had a feature or a display, or whether the price reduction was in any way comparable to the price reduction in the promotion we are forecasting for. The base-lift method, in this particular setup, is little more than a straw man that may improve on the simplest naive forecast, but certainly not by much, and it is certainly not state of the art, and Appendix B of Fildes et al. (2018) indicates that it is not all that common: none of the five cases tabulated use it.

We now revise it by introducing the Base-lift model as “a model which has been used as the benchmark model in previous studies”, and we also change the sentence in the last section “Our models significantly outperform the industrial practice.” to “Our models significantly outperform the Base-lift model.”. We also cite Fildes, et al. (2018) in the last section of the study and highlight that nowadays practitioners tend to take advantages of econometric models (and this is why we compared the forecasting performance of our proposed methods with those conventional econometric models which have similar specifications but overlooks the problem of structural change). We add the following sentence in the last section of the paper:

“In this study, we also compare the forecasting performance of our proposed methods with conventional econometric models which have similar specifications but overlook the structural change problem. The ADL-intra-EWC method and the ADL-intra-IC method outperform the ADL-intra model, and the ADL-own-EWC method and the ADL-own-IC method outperform the ADL-own model. We conduct the comparison to highlight the benefit of taking into account the problem of structural change as some retailers have tried to take advantage of conventional econometric models (Fildes, et al., 2018).”

I am still not convinced by section 8. By the time I had arrived here, I was well and truly confused, and this would have been a good point to stop the paper. Instead, we get a PCA (is this a PCA?) that adds yet another layer of abstraction, and all of it post hoc. I find this section weak and unconvincing. Please consider cutting it.

We now remove this section but we briefly summarize some of the findings in the last section. We make it clear that the exploratory results themselves are worth considering in relation to what we are proposing and worthy of further analysis.

Please proofread the manuscript carefully. There are many mentions of "Mariana" which should be "Mariano". Often, citations indicate that an author has different first names and/or initials in the literature database, which leads EndNote to believe that these refer to different people, and to erroneously disambuguate them. In the list of references, Wildt et al. seems to have been edited by someone named "E. proceedings".

Revised. We have proofread the manuscript and have in that respect asked a professional proofreading editor to help us with the task. We have also corrected the list of references.

Reviewer #2: I am happy to see that the authors managed to overcome many deficiencies of the original draft. Although, originally I thought that the manuscript was to be rejected, to my surprise this version of the paper is much improved in all aspects hopefully through my comments and those of the other reviewer.

The literature review is now on spot, contributions are clearly explained, methodology is vastly easier to read through and it is easy to understand the process that the authors follow. As a result, the whole positioning of the manuscript in the sales forecasting respective literature along with the OR one overall is successful. Therefore, I would now recommend that this manuscript is accepted with minor revisions, as long as the editor agrees.

Those revisions are merely the polishing of the paper in terms of the writing. I would suggest one more check for typos and reduction of 'we...' across the manuscript.

We thank the reviewer for his/her comments and appreciation of our work and have proofread the document for typos whilst also revising the changes suggested by reviewer 1.