**Supplementary Material for:**

The effects of Veganuary on meal choices in workplace cafeterias: an interrupted time series analysis

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# Supporting Information Text

## Details of data exclusion

*Initial dataset*

The main dataset initially comprised daily sales of main meals[[1]](#footnote-2) from 29/09/2016 to 02/03/2022, in 131 workplace cafeterias[[2]](#footnote-3) (henceforth referred to as “branches”) of 11 client companies the catering company served in the UK. Sales here and elsewhere in the report refer to number of meals sold, i.e., unit sales, rather than the monetary value of sales.

There were 1,975 dates in total during the study time period. Over this period, 4,677,540 meals were sold, with 2,396 distinct meal products (henceforth “products” refer to “meal products”). A separate dataset contained indicators for each of the meal products that denoted whether they were vegetarian or vegan options.

There were 1,411 weekdays in the dataset. Weekends were excluded from the dataset, as many branches do not operate over the weekend. As such, we would have had a selective set of branches with data for weekends, which would have been detrimental to our intended approach to analysis.

*Exclusions and missing data*

Following Velicer and Colby (2005), we initially excluded branches that had no data for more than 20 percent of the weekdays in the period. There were 57 branches with at least 80 percent of the weekdays (>1129). We further excluded nine branches that had missing data for two consecutive weeks, because imputation with consecutive missing values has been shown to be more inaccurate (Wongoutong, 2020). 43 of the remaining 48 branches had data until 23/02/2022; one had data until 22/02/2022; and another had data until 21/02/2022. We removed the other three branches whose data ended before February 2022, which left us with 45 branches that spanned the total study period.

Finally, due to high variance in the raw data and low absolute volumes of vegetarian and vegan sales, the results of imputation (the process for which is described below) for a 45-branch set was relatively inaccurate, particularly for vegan sales.[[3]](#footnote-4) Consequently, we further removed nine branches with more than 5 percent missing data, which left us with 36 branches from five client companies the catering company served in the final dataset.

Note that since the data covered the COVID period, shutdowns during COVID would have led to missing data for branches. Consequently, the exclusion procedure could have led to a selection of branches that were open consistently during the COVID lockdown periods, which should be noted as potential limitation of the study.

## Model fitting for vegan sales

**Model fitting – Pre-campaign model**

An ARIMA (3,1,1) (0,0,0)52 model without drift provided the best fit for the unperturbed data (29/09/2016 to 30/12/2018), based on the AIC (AIC = -828.087). See Table S6 for the fit of alternative models. An augmented Dickey-Fuller test confirmed the need for differencing (ADF = -3.351, *p* = .066).

Examination of the model residuals – including their ACF – indicated a satisfactory fit, an observation corroborated by the Ljung-Box Q statistic (Q = 13.825, *p* = .839). Model parameter estimates can be seen in Table S5.

**Model fitting – Intervention analysis**

Following the pre-campaign model, an ARIMA (3,1,0) (0,0,0)52 was fitted to the data. ARIMA (3,1,1) (0,0,0)52 model was fitted to the full time series including four transfer functions; however, the MA parameter was not statistically significant, so it was removed from the model. Additionally, the intervention transfer functions were adjusted on the basis of statistical significance. The model contained three transfer functions (for the 2020, 2021 and 2022 campaign periods) and three outliers (two innovative outliers and an additive outlier).

The three transfer functions took the form , where ω1 represents the immediate effect of the campaign and represents the subsequent decay in campaign effect over time (Cryer and Chan, 2008). Examination of the residuals again indicated a satisfactory fit, corroborated once more by the Ljung-Box test (Q = 49.411,*p* = .301). The model’s parameter estimates can be seen in Table 2 in the main text.

Additional outputs of this model are in Figure S4 and Figure S5. Results of secondary outcomes are in Table S7.

## Model fitting for vegetarian sales

**Model fitting – Pre-campaign model**

An ARIMA (4,0,0) (0,0,0)52 model with an intercept and no drift provided the best fit for the unperturbed data (29/09/2016 to 30/12/2018), based on the AIC (AIC = -654.13). See Table S9 for the fit of alternative models. An augmented Dickey-Fuller test confirmed that no differencing was needed (ADF = -4.022, *p* = .011). Model residuals indicated a satisfactory fit, confirmed by the Ljung-Box Q statistic (Q = 21.126, *p* = .323). Model parameter estimates can be seen in Table S8.

**Model fitting – Intervention analysis**

Following the pre-campaign model, an ARIMA (4,0,0) (0,0,0)52 model with an intercept was fitted to the data. ARIMA (4,0,0) (0,0,0)52 model was fitted to the full time series including four transfer functions; the intervention transfer functions were adjusted on the basis of statistical significance. The model contained three transfer functions (for the 2019, 2021 and 2022 campaign periods) and 10 outliers (seven innovative outliers and three additive outliers). As for the vegan analysis, the transfer functions took the form . Examination of the residuals indicated an acceptable fit, corroborated once more by the Ljung-Box Q statistic (Q = 47.832, *p* = .090). The model’s parameter estimates can be seen in Table 3 in the main text.

Additional outputs of this model are in Figure S6 and Figure S7. Results of secondary outcomes are in Table S10 and Table S11.

## Consistency of observed treatment effects

The key message is that, in contrast to the findings from the aggregate data across 36 branches, looking at the data of one randomly selected branch, no campaign effects were found for proportion of vegan sales, and effects were only found for the 2019 campaign for proportion of vegetarian sales, suggesting that the campaign effects differed across branches.

To investigate the consistency of the treatment effects, we randomly selected a single cafeteria using the *randomizr* package in R and modelled the impact of the promotional periods at that location.

The randomly selected branch was relatively large compared to other branches in this study, with average sales of 439.771 products per week, compared to a total average (221.379 products per week).

**Vegan sales**

The proportion of total weekly sales accounted for by vegan products in the selected branch is depicted in Figure S2. There was more variability in the selected cafeteria’s vegan sales relative to the aggregate; vegan sales accounted for approximately 0-14% of total product sales depending on the week and year. In contrast to the aggregate analysis, changes in the mean and variance of vegan sales did not clearly coincide with campaign periods, aside from in 2020.

**Model fitting – Intervention analysis**

For the intervention analysis, an ARIMA (4,0,0) (0,0,0)52 model with an intercept was fitted. An augmented Dickey-Fuller test confirmed differencing was not needed (ADF = -4.322, *p* = .01). The model residuals indicated an acceptable fit, subsequently confirmed by the Ljung-Box test (Q = 53.437,*p* = .111).

As Table S14 shows, the vegan product sales treatment effects observed for the aggregate were not observed in the randomly selected branch. Specifically, none of the transfer functions for the 2020 ( 2020 = -0.001), 2021 ( 2021 = -0.007) and 2022 ( 2022 = -0.007) campaigns were statistically significant and were near zero in value, suggesting a negligible campaign impact.

**Vegetarian sales**

In comparison to the branch’s vegan sales, vegetarian sales were more consistent across the time series (see Figure S3). Aside from a significant decrease in the latter half of 2019 – which coincided with a reduction in the availability of vegan products across the aggregate dataset – vegetarian sales accounted for approximately 10% of the branch’s sales, on average.

**Model fitting – Intervention analysis**

In intervention analysis, an ARIMA (0,0,4) (0,0,0)52 model with an intercept was fitted. An augmented Dickey-Fuller test confirmed differencing was not needed (ADF = -4.914, *p* = .01). Model residuals suggested the model was acceptable, confirmed by the Ljung-Box test (Q = 51.305, *p* = .345).

As Table S15 indicates, only one of the treatment effects for vegetarian products observed for the aggregate was also observed in the chosen branch. While there was a relatively large 11.9 percentage point increase in the purchase of vegetarian products in the 2019 campaign period ( 2019 = 0.119, *p* < .05), there were no statistically significant changes in sales in 2021 and 2022.

## Study Limitations

This study also has several limitations. First, the exclusion procedure could have led to selection bias in the set of branches included in the final dataset. We excluded branches with more than 5% missing data or that had missing data for two consecutive weeks, in order to ensure quality of data after imputation. However, exclusion of these branches could potentially have led to sample bias. For example, if the amount of missing data was correlated with level of sales, then we could have ended up selecting relatively larger cafeterias. Also, as relatively longer periods of shutdown during the COVID-19 pandemic would have led to a substantial amount of missing data, the exclusion procedure should have also resulted in selection of branches that were open consistently during the COVID-19 lockdown periods. We did not have data on the characteristics of the cafeterias to examine the potential selection bias, but one should bear such issues in mind when interpreting and generalising the findings. In addition, a substantial amount of imputation was required to populate missing values in the dataset. While this is not a problem in and of itself, the variability in data across days, weeks and years lowered the accuracy of imputation for vegan sales, in particular. Nonetheless, the study dataset only included branches in which missing data accounted for less than 5% of the total time series; therefore, we maintain that the overall impact of this imputation is likely to be minimal.

The second limitation of this study is that the campaign was only implemented in a limited number of cafeterias in the United Kingdom, which belonged to a selected set of client companies served by the large catering company. While the number of cafeterias in this study’s dataset was large compared to many in the literature, the extent to which the results may be generalised – that is, whether similar interventions could be implemented at scale (including internationally) – remains unclear. Indeed, in this study’s sensitivity analysis, the annual campaign effects observed at an aggregate level were not consistently observed for a randomly selected branch. Similarly, Pechey et al found that effects only existed in two out of the six worksite cafeterias they studied, suggesting that a degree of heterogeneity of effect might be a general feature of such interventions and should be investigated in future research (Pechey *et al.*, 2019).

The third limitation of this study is that limited information was available about the details of the annual campaign activities and the fidelity of the implementation of the campaign activities across the cafeterias. Differential level of fidelity could contribute to the inconsistency of effects between the aggregate level and the individual branch level; lower fidelity was also likely to be a problem during the Covid period when supply chain issues were serious.[[4]](#footnote-5) Lack of data on intervention implementation restricts our ability to conduct more detailed and in-depth examination of the mechanisms that drove the intervention effects and the heterogeneity across years and branches.

Future studies should also seek to examine the extent to which the efficacy of similar interventions – which manipulate the choice architecture in cafeterias and similar outlets – may be enhanced by other interventions. Research has indicated that traditional economic interventions, such as small discounts, can increase the sales of sustainable foods (Garnett *et al.*, 2019); however, the extent to which such interventions can work in concert should be explored.

# Chart, scatter chart Description automatically generatedFigures

## Figure S 1 Vegan/Vegetarian products (weekly), proportion of total products

Chart, histogram

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## Figure S 2 Vegan sales (weekly), proportion of total sales (selected branch)

## Figure S 3 Vegetarian sales (weekly), proportion of total sales (selected branch)

Chart

Description automatically generated

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## Figure S 4 Distribution of standardised residuals and ACF, pre-campaign ARIMA (3,1,1) (0,0,0)52 model (vegan)

A picture containing antenna

Description automatically generated

## Figure S 5 Distribution of standardised residuals and ACF, full time series ARIMA (3,1,0) (0,0,0)52 model (vegan)

Chart

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A picture containing shape

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## Figure S 6 Distribution of standardised residuals and ACF, pre-campaign ARIMA (4,0,0) (0,0,0)52 model (vegetarian)



A picture containing bar chart

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## Figure S 7 Distribution of standardised residuals and ACF, full time series ARIMA (4,0,0) (0,0,0)52 model (vegetarian)

Chart

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**3. Tables**

## Table S 1 Summary of key numbers for included and excluded branches

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Branches** | **Average of meals sold per day** | **Average of vegan meals sold per day** | **Average of vegetarian meals sold per day** | **Average of days with sales data in the dataset** | **Average of proportion of vegetarian meals sold per day** | **Average of proportion of vegan meals sold per day** |
| All branches N = 131 | 35.63 | 0.59 | 4.47 | 1160 | 0.12 | 0.02 |
| Branches with missing data for >20% weekdays  N=131-57=74 | 30.81 | 0.55 | 4.35 | 822 | 0.13 | 0.02 |
| Branches with missing data for two consecutive weeks (among those surviving the exclusion above) N=57-45=12 | 29.88 | 0.28 | 2.44 | 1248 | 0.09 | 0.01 |
| Branches with more than 5% missing data (among those surviving the exclusions above) N=45-36=9 | 20.13 | 0.32 | 2.73 | 1310 | 0.14 | 0.02 |
| Final 36 Branches | 44.93 | 0.78 | 5.59 | 1367 | 0.13 | 0.02 |

## Table S 2 Summary of key numbers for vegan sales

|  |  |  |
| --- | --- | --- |
| **Period** | **Proportion of total sales accounted by vegan products (weekly on average)** | **Number of vegan products sold (weekly on average)** |
| Baseline period | 1.86% (SD = 0.714%) | 164 (SD = 72) |
| January 2017 | 2.05% (SD = 0.770%) | 197 (SD = 71) |
| January 2018 | 1.68% (SD = 0.422%) | 139 (SD = 71) |
| Immediate effects of 2019 campaign | Not significant | Not significant |
| Immediate effects of 2020 campaign | +1.6% (*p* < .001) | Around 107 extra vegan meals sold per week |
| Immediate effects of 2021 campaign | +2.1% (*p* < .001) | Around 190 extra vegan meals sold per week |
| Immediate effects of 2022 campaign | +2.1% (*p* < .001) | Around 181 extra vegan meals sold per week |

## Table S 3 Summary of key numbers for vegetarian sales

|  |  |  |
| --- | --- | --- |
| **Period** | **Proportion of total sales accounted by vegetarian products (weekly on average)** | **Number of vegetarian products sold (weekly on average)** |
| Baseline period | 12.22% (SD = 1.57%) | 1077 (SD = 226) |
| January 2017 | 11.74% (SD = 1.04%) | 1138 (SD = 125) |
| January 2018 | 12.50% (SD = 0.518%) | 1036 (SD = 32) |
| Immediate effects of 2019 campaign | +3.2% (*p* <.01) | Around 232 extra vegetarian meals sold per week |
| Immediate effects of 2020 campaign | Not significant | Not significant |
| Immediate effects of 2021 campaign | +2.8% (*p* < .01) | Around 253 extra vegetarian meals sold per week |
| Immediate effects of 2022 campaign | +9.7% (*p* < .001) | Around 835 extra vegetarian meals sold per week |

## Table S 4 Prices of vegan, vegetarian and non-vegetarian products for each year

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Year** | **Average amount paid for a vegetarian meal (£)** | **Average amount paid for a vegan meal (£)** | **Average amount paid for a non-vegetarian meal (£)** | **Ratio of vegetarian to non-vegetarian meal** | **Ratio of vegan to non-vegetarian meal** |
| 2017 | 2.36 | 2.65 | 2.75 | 85.8% | 96.3% |
| 2018 | 2.32 | 2.17 | 2.62 | 88.4% | 82.9% |
| 2019 | 2.39 | 2.23 | 2.81 | 85.0% | 79.4% |
| 2020 | 2.36 | 2.87 | 2.78 | 84.7% | 103.2% |
| 2021 | 2.53 | 2.64 | 2.81 | 90.3% | 94.2% |
| 2022 | 2.70 | 2.75 | 2.71 | 99.4% | 101.4% |

## Table S 5 Pre-campaign ARIMA (3,1,1) (0,0,0)52 model parameters, vegan

| **Parameter** | **Coefficient** | **Standard error** | **P-value** |
| --- | --- | --- | --- |
| AR(1) | -0.331 | 0.119 | *p* < .01 |
| AR(2) | -0.390 | 0.110 | *p* < .001 |
| AR(3) | -0.315 | 0.110 | *p* < .01 |
| MA(1) | -0.717 | 0.097 | *p* < .001 |
| Log likelihood = 419.04, AIC=-828.09 | | | |

## Table S 6 Alternative ARIMA models for the pre-campaign period, including AIC values, vegan

|  |  |  |
| --- | --- | --- |
| **Model** | **With drift?** | **AIC** |
| ARIMA(2,1,2) | With drift | -823.492 |
| ARIMA(0,1,0) | With drift | -744.793 |
| ARIMA(1,1,0) | With drift | -768.809 |
| ARIMA(0,1,1) | With drift | -819.829 |
| ARIMA(0,1,0) | - | -746.772 |
| ARIMA(2,1,1) | With drift | -821.979 |
| ARIMA(3,1,2) | With drift | -824.978 |
| ARIMA(3,1,1) | With drift | -826.925 |
| ARIMA(3,1,0) | With drift | -810.487 |
| ARIMA(4,1,1) | With drift | -824.989 |
| ARIMA(2,1,0) | With drift | -782.973 |
| ARIMA(4,1,0) | With drift | -818.235 |
| ARIMA(3,1,1) | - | -828.087 |
| ARIMA(2,1,1) | - | -822.809 |
| ARIMA(3,1,0) | - | -812.401 |
| **Model** | **With drift?** | **AIC** |
| ARIMA(4,1,1) | - | -826.112 |
| ARIMA(3,1,2) | - | -826.109 |
| ARIMA(2,1,0) | - | -784.946 |
| ARIMA(2,1,2) | - | -824.704 |
| ARIMA(4,1,0) | - | -820.066 |
| ARIMA(4,1,2) | - | -824.65 |
| ARIMA(2,1,2)(0,1,0)[52] | - | -403.2494 |
| ARIMA(0,1,0)(0,1,0)[52] | - | -364.5596 |
| ARIMA(1,1,0)(0,1,0)[52] | - | -380.213 |
| ARIMA(0,1,1)(0,1,0)[52] | - | -405.5357 |
| ARIMA(1,1,1)(0,1,0)[52] | - | -404.6834 |
| ARIMA(0,1,2)(0,1,0)[52] | - | -405.3587 |
| ARIMA(1,1,2)(0,1,0)[52] | - | -404.5259 |

**Intervention analysis - outliers**

Aside from the campaign periods, highly significant innovative and additive outliers[[5]](#footnote-6) were detected. Innovative outliers were observed in Weeks 207 and 240 (weeks 37 and 17 of 2020 and 2021, respectively), and an additive outlier was observed in Week 180 (week 10 of 2000). The lack of periodicity between these outliers suggests that these are not related to seasonal consumption patterns.

**Secondary outcomes, total sales (vegan)**

A different model was fitted to these data: an ARIMA (0,1,1) (0,0,0)52. Examination of model residuals indicated an acceptable fit, corroborated by the Ljung-Box Q-statistic (Q = 54.20, *p* = .139). The results of this model suggested a similar pattern of results to the primary analysis: significant effects were observed for the 2020, 2021 and 2022 campaign periods, with the smallest peak magnitude observed for 2020 (ω1 2020 = 135.249, *p* < .01), and broadly similar peak magnitudes observed for 2021 (ω1 2021 = 156.950, *p* < .05) and 2022 (ω1 2022 = 166.558, *p* < .01).

## Table S 7 Secondary analysis (absolute vegan weekly sales), ARIMA (0,1,1) (0,0,0)52 model parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Coefficient** | **Standard error** | **P-value** |
| MA(1) | -0.819 | 0.034 | *p* < .001 |
| AOL, Week 10 (2016) | 244.690 | 60.447 | *p* < .001 |
| AOL, Week 180 (2020) | 197.091 | 59.585 | *p* < .001 |
| IOL, Week 11 (2016) | 188.390 | 63.493 | *p* < .01 |
| IOL, Week 207 (2020) | 150.534 | 62.328 | *p* < .05 |
| IOL, Week 224 (2021) | 109.466 | 62.325 | *p* = .079 |
| IOL, Week 238 (2021) | 240.949 | 62.331 | *p* < .001 |
| 2020 | 135.249 | 59.725 | *p* < .05 |
| 2020 | 0.095 | 0.036 | *p* < .01 |
| 2021\* | 156.950 | 60.934 | *p* < .05 |
| 2021 | 0.130 | 0.015 | *p* < .001 |
| 2022 | 166.558 | 63.036 | *p* < .01 |
| 2022 | 0.263 | 0.090 | *p* < .01 |
| Log likelihood = -1565.86, AIC = 3157.72  \* 2021’s impact was lagged a week in this model | | | |

## Table S 8 Pre-campaign ARIMA (4,0,0) (0,0,0)52 model parameters, vegetarian

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Coefficient** | **Standard error** | **P-value** |
| AR(1) | -0.057 | 0.087 | *p* = .507 |
| AR(2) | 0.030 | 0.086 | *p* = .728 |
| AR(3) | -0.127 | 0.088 | *p* = .146 |
| AR(4) | 0.337 | 0.088 | *p* < .001 |
| Log likelihood = 333.07, AIC=-654.13 | | | |

## Table S 9 Alternative ARIMA models for the pre-campaign period, including AIC values, vegetarian

|  |  |  |
| --- | --- | --- |
| **Model** | **Mean** | **AIC** |
| ARIMA(0,0,0) | With zero mean | -157.3592 |
| ARIMA(0,0,0) | With non-zero mean | -641.7266 |
| ARIMA(0,0,1) | With zero mean | -264.234 |
| ARIMA(0,0,1) | With non-zero mean | -641.7996 |
| ARIMA(0,0,2) | With zero mean | -363.4315 |
| ARIMA(0,0,2) | With non-zero mean | -640.0633 |
| ARIMA(0,0,3) | With zero mean | -396.9117 |
| ARIMA(0,0,3) | With non-zero mean | -640.8059 |
| ARIMA(0,0,4) | With zero mean | -425.0282 |
| ARIMA(0,0,4) | With non-zero mean | -648.698 |
| ARIMA(0,0,5) | With zero mean | -454.3674 |
| ARIMA(0,0,5) | With non-zero mean | -647.0897 |
| ARIMA(1,0,0) | With zero mean | -541.756 |
| ARIMA(1,0,0) | With non-zero mean | -642.0666 |
| ARIMA(1,0,2) | With non-zero mean | -638.22 |
| ARIMA(1,0,3) | With non-zero mean | -649.6786 |
| ARIMA(1,0,4) | With non-zero mean | -646.9031 |
| **Model** | **Mean** | **AIC** |
| ARIMA(2,0,0) | With non-zero mean | -640.6975 |
| ARIMA(2,0,1) | With non-zero mean | -638.3395 |
| ARIMA(3,0,0) | With non-zero mean | -642.2764 |
| ARIMA(3,0,1) | With non-zero mean | -650.281 |
| ARIMA(3,0,2) | With non-zero mean | -648.5888 |
| **ARIMA(4,0,0)** | With non-zero mean | **-654.1311** |
| ARIMA(4,0,1) | With non-zero mean | -652.2098 |
| ARIMA(5,0,0) | With non-zero mean | -652.2488 |

**Outliers**

Aside from the campaign periods, highly significant innovative and additive outliers were detected. Innovative outliers were observed in Week 140 (week 22 of 2019), Week 236-239 (week 13-16 of 2021), Week 251 (week 28 of 2021), and Week 278 (week 3 of 2022). Additive outliers were observed in Week 14 (week 52 of 2016), Week 35 (week 21 of 2017), and Week 240 (week 17 of 2021).

**Secondary outcomes, total sales (vegetarian)**

A different model was fitted to these data: an ARIMA (15,0,0) (1,0,0)52 with three transfer functions taking the same form as the primary analysis. Examination of model residuals indicated an acceptable fit, corroborated by the Ljung-Box Q-statistic (Q = 34.89, *p* = .378).

The coefficients denoting the campaign period for the 2019 (ω1 2019 = 183.943, *p* = .270), 2021 ( 2021 = 227.618, *p* = .190) and 2022 ( 2022 = 319.043, *p* = .101) were not statistically significant, likely due to challenges modelling the outcome due to additional variability in the outcome variable. Nonetheless, they had a broadly similar pattern to those from the primary analysis: the highest parameter coefficient was observed for 2022.

## Table S 10 Secondary analysis (absolute vegetarian weekly sales), ARIMA (15,0,0) (1,0,0)52 model parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Coefficient** | **Standard error** | **P-value** |
| AR(1) | 0.028 | 0.060 | *p* = .640 |
| AR(2) | 0.394 | 0.059 | *p* < .001 |
| AR(3) | -0.004 | 0.066 | *p* = .953 |
| AR(4) | 0.304 | 0.064 | *p* < .001 |
| AR(5) | -0.092 | 0.066 | *p* = .163 |
| AR(6) | -0.115 | 0.066 | *p* = .082 |
| AR(7) | 0.105 | 0.067 | *p* = .118 |
| AR(8) | 0.158 | 0.066 | *p* < .05 |
| AR(9) | 0.084 | 0.066 | *p* = .208 |
| AR(10) | -0.072 | 0.067 | *p* = .281 |
| AR(11) | 0.070 | 0.068 | *p* = .301 |
| AR(12) | -0.086 | 0.064 | *p* = .184 |
| AR(13) | 0.163 | 0.066 | *p* < .05 |
| AR(14) | -0.028 | 0.062 | *p* = .652 |
| AR(15) | -0.227 | 0.062 | *p* < .001 |
| SAR(1) | 0.325 | 0.074 | *p* < .001 |
| Intercept | 988.803 | 51.632 | *p* < .001 |
| IOL, Week 225 (2021) | 950.170 | 207.314 | *p* < .001 |
| 2019 | 183.943 | 166.773 | *p* = .270 |
| 2019 | 0.000 | 0.014 | *p* = .990 |
| 2021 | 227.618 | 173.531 | *p* = .190 |
| **Parameter** | **Coefficient** | **Standard error** | **P-value** |
| 2021 | 0.000 | 0.023 | *p* = .983 |
| 2022 | 319.043 | 194.408 | *p* = .101 |
| 2022 | 0.004 | 0.070 | *p* = .950 |
| Log likelihood = -1907.25, AIC = 3862.5 | | | |

**Secondary outcomes, total sales (all products)**

A different model was fitted to these data: an ARIMA (3,1,0) (0,1,1)52 with four transfer functions taking the simple form , where represented the immediate effect of the intervention. Examination of model residuals indicated an acceptable fit, corroborated by the Ljung-Box Q-statistic (Q = 57.69, *p* = .097).

The results of this model suggested a significant increase in total sales in the 2021 campaign period, and no significant changes of total sales in the 2019, 2020 and 2022 campaign periods.

## Table S 11 Secondary analysis (absolute total weekly sales), ARIMA (3,1,0) (0,1,1)52 model parameters

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Coefficient** | **Standard error** | **P-value** |
| AR(1) | -0.636 | 0.079 | *p* < .001 |
| AR(2) | -0.228 | 0.092 | *p* < .05 |
| AR(3) | -0.285 | 0.075 | *p* < .001 |
| SMA(1) | -0.380 | 0.081 | *p* < .001 |
| AOL, Week 54 (2017) | -884.482 | 565.176 | *p* = .118 |
| AOL, Week 55 (2017) | -512.342 | 542.635 | *p* = .345 |
| AOL, Week 222 (2020) | 872.831 | 554.933 | *p* = .116 |
| AOL, Week 283 (2022) | -4110.166 | 717.997 | *p* < .001 |
| 2019 | 446.066 | 571.986 | *p* = .435 |
| 2020 | 435.884 | 595.587 | *p* = .464 |
| 2021 | 2243.308 | 599.502 | *p* < .001 |
| 2022 | -1024.164 | 652.039 | *p* = .116 |
| Log likelihood = -1840.95, AIC = 3705.9 | | | |

**Sensitivity analysis – Individual branch**

**Model fitting – Pre-campaign model, vegan**

An ARIMA (3,1,0) (0,0,0)52 model without drift was the best fit for the unperturbed data, based on AIC (AIC = -547.39). An augmented Dickey-Fuller test confirmed differencing was needed (ADF = -2.875, *p* = .213). The model residuals indicated a satisfactory fit, confirmed by the Ljung-Box Q statistic (Q = 19.107, *p* = .839).

Model parameters can be seen below in Table S12.

## Table S 12 Pre-campaign ARIMA (3,1,0) (0,0,0)52 model parameters (selected branch), vegan

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Coefficient** | **Standard error** | **P-value** |
| AR(1) | -0.730 | 0.085 | *p* < .001 |
| AR(2) | -0.710 | 0.092 | *p* < .001 |
| AR(3) | -0.515 | 0.086 | *p* < .001 |
| Log likelihood = 283.22, AIC= -547.39 | | | |

**Model fitting – Pre-campaign model, vegetarian**

An ARIMA (0,0,5) (0,0,0)52 model with an intercept was the best fit for the unperturbed data, based on AIC (AIC = -356.67). An augmented Dickey-Fuller test confirmed that data were stationary (ADF = -4.0127, *p* < 0.05). The model residuals indicated an acceptable fit, confirmed by the Ljung-Box Q statistic (Q = 10.859, *p* = 0.900).

Model parameters can be seen below in Table S13.

## Table S 13 Pre-campaign ARIMA (0,0,5) (0,0,0)52 model parameters (selected branch), vegetarian

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Coefficient** | **Standard error** | **P-value** |
| MA(1) | 0.033 | 0.097 | *p* = .736 |
| MA(2) | 0.050 | 0.087 | *p* = .557 |
| MA(3) | -0.037 | 0.096 | *p* = .699 |
| MA(4) | 0.349 | 0.094 | *p* < .001 |
| MA(5) | -0.154 | 0.094 | *p* = .102 |
| Intercept | 0.113 | 0.006 | *p* < .001 |
| Log likelihood = 283.22, AIC= -547.39 | | | |

## Table S 14 Full time series ARIMA (4,0,0) (0,0,0)52 model parameters, vegan (selected branch)

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Coefficient** | **Standard error** | **P-value** |
| AR(1) | 0.103 | 0.046 | *p* < .05 |
| AR(2) | 0.054 | 0.046 | *p* = .240 |
| AR(3) | 0.105 | 0.047 | *p* < .05 |
| AR(4) | 0.283 | 0.047 | *p* < .001 |
| Intercept | 0.012 | 0.002 | *p* < .001 |
| AOL, Week 138 (2019) | 0.090 | 0.016 | *p* < .001 |
| AOL, Week 173 (2020) | 0.079 | 0.016 | *p* < .001 |
| AOL, Week 197 (2020) | 0.056 | 0.017 | *p* < .001 |
| IOL, Week 96 (2018) | 0.072 | 0.016 | *p* < .001 |
| IOL, Week 114 (2018) | 0.082 | 0.017 | *p* < .001 |
| IOL, Week 129 (2019) | 0.095 | 0.016 | *p* < .001 |
| IOL, Week 241 (2021) | 0.082 | 0.016 | *p* < .001 |
| 2020 | -0.001 | 0.016 | *p* = .953 |
| 2021 | -0.007 | 0.016 | *p* = .649 |
| 2022 | -0.007 | 0.016 | *p* = .653 |
| Log likelihood = 760.08, AIC = -1490.17 | | | |

## Table S 15 Full time series ARIMA (0,0,4) (0,0,0)52 model parameters, vegetarian (selected branch)

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **Coefficient** | **Standard error** | **P-value** |
| MA(1) | 0.021 | 0.057 | *p* = .718 |
| MA(2) | 0.114 | 0.057 | *p* < .05 |
| MA(3) | 0.057 | 0.057 | *p* = .316 |
| MA(4) | 0.278 | 0.057 | *p* < .001 |
| Intercept | 0.100 | 0.005 | *p* < .001 |
| IOL, Week 206 (2019) | 0.195 | 0.056 | *p* < .001 |
| 2019 | 0.119 | 0.053 | *p* < .05 |
| 2021 | -0.013 | 0.053 | *p* = .805 |
| 2022 | 0.070 | 0.053 | *p* = .189 |
| Log likelihood = 419.12, AIC = -820.23 | | | |

## Table S 16 Full time series ARIMA (3,1,1) (0,0,0)52 model parameters including additional cafeterias with higher level of missing data, vegan

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Coefficient** | **Standard error** | ***p*-value** | |
| AR(1) | -0.792 | 0.051 | *p* < .001 | |
| AR(2) | -0.589 | 0.060 | *p* < .001 | |
| AR(3) | -0.483 | 0.051 | *p* < .001 | |
| AOL, Week 180 (2020) | 0.022 | 0.006 | *p* < .001 | |
| IOL, Week 207 (2020) | 0.030 | 0.007 | *p* < .001 | |
| IOL, Week 240 (2021) | 0.028 | 0.008 | *p* < .001 | |
| 2020 | 0.015 | 0.005 | *p* < .01 | |
| 2020 | 0.968 | 0.052 | *p* < .001 | |
| 2021 | 0.021 | 0.005 | *p* < .001 | |
| 2021 | 0.981 | 0.036 | *p* < .001 | |
| 2022 | 0.025 | 0.006 | *p* < .001 | |
| 2022 | 0.336 | 0.246 | *p* = .172 | |
| Log likelihood = 988.04, AIC = -1952.08 | | | |

## Table S 17 Full time series ARIMA (3,1,1) (0,0,0)52 model parameters removing the two largest units, vegan

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Coefficient** | **Standard error** | ***p*-value** | |
| AR(1) | -0.771 | 0.050 | *p* < .001 | |
| AR(2) | -0.583 | 0.060 | *p* < .001 | |
| AR(3) | -0.499 | 0.051 | *p* < .001 | |
| AOL, Week 180 (2020) | 0.022 | 0.006 | *p* < .001 | |
| IOL, Week 207 (2020) | 0.024 | 0.007 | *p* < .001 | |
| IOL, Week 240 (2021) | 0.035 | 0.007 | *p* < .001 | |
| 2020 | 0.017 | 0.005 | *p* < .001 | |
| 2020 | 0.969 | 0.048 | *p* < .001 | |
| 2021 | 0.018 | 0.005 | *p* < .001 | |
| 2021 | 0.978 | 0.038 | *p* < .001 | |
| 2022 | 0.021 | 0.006 | *p* < .001 | |
| 2022 | 0.534 | 0.268 | *p* < .05 | |
| Log likelihood = 994.63, AIC = -1965.26 | | | |

# References

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1. We focused on main meals, with sandwiches and snacks not included because the campaign activities were designed around main meal products mostly. [↑](#footnote-ref-2)
2. The majority of these cafeterias served mostly blue collar workers. [↑](#footnote-ref-3)
3. A correlation coefficient of 0.55. [↑](#footnote-ref-4)
4. In addition to the problems of missing data/exclusion of branches and implementation fidelity, total footfall and sales may have been lower during the COVID period as well. We did not have information on the operation of the workplace cafeterias, but we did observe a drop of total sales in the second quarter of 2020 using the final dataset; however, the level bounced back in the second half of 2020 and was higher in 2021 than the pre-COVID level. We expected the ARIMA model to capture these trends in the time series data; in addition, if there was any significant shock that resulted in a large temporary change in the outcome variables, it would have been captured by the outliers detected in the modelling procedure (see the methods section for more details on outlier detection). More importantly, we used proportions of vegan/vegetarian sales out of total sales, rather than the absolute vegan/vegetarian sales as our primary outcome variables; unlike the absolute sales level, the data of the two primary outcomes did not exhibit significant changes during the COVID period. [↑](#footnote-ref-5)
5. Innovative outliers refer to outliers which have an effect on subsequent observations, while additive outliers refer to those which do not. See (Chang, Tiao and Chen, 1988). [↑](#footnote-ref-6)