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**Research Article**

# Comparison Between TV and Digital Advertisements of Fast-Food Chains

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**Abstract**
Among the major fast-food chains, the mean TV advertising spending is 38 times that of digital advertising spending in 2019. However, TV advertising spending is negatively correlated with the current and future sales, while digital advertising spending is positively correlated. That is, digital advertising spending such as operating social network services is more directly related to the short-term purchase intention of fast-food consumers. Moreover, Hispanic youth reveal different patterns from Black youth or all youth, in terms that their purchase intentions are more directly responsive to TV commercials. In this respect, the increase in Spanish-language TV advertisements constructs a different and separate realm; it is negatively correlated with sales while almost uncorrelated with brand awareness of existing market. Therefore, in principal component analysis, digital spending might be interpreted as a kind of strengthening of existing market power, while Spanish-language TV advertisement would be a sort of a new market penetration. Regarding childhood obesity, digital spending and Spanish-language TV ads should receive more concern to determine appropriate and effective policy responses.
**Keywords**: DPD (Dynamic Panel Data), PCA (Principal Component Analysis), Fast-Food Chains, Digital Spending, Childhood Obesity.

## 1. Introduction

The global fast-food industry is exhibiting fast growth. This market is expected to reach $1.25 trillion by 2033, up from $788.72 billion in 2024. Along with the fast growth of this industry, its high calories, fat, and sugar content as well as low nutrient value constantly triggers health concerns. Under these current circumstances, several questions raised in this study are:
(1) What are the differences among 4 advertisement methods of fast-food chains?
(2) What is the implication of increasing Spanish-targeted TV ads and Black-targeted TV ads by fast-food chains?
(3) Are there any typical aspects of Spanish-targeted and Black-targeted TV ads exposures?
(4) Are there any characteristics of ads enhancing health concerns?

To answer these questions, data sets from Fast Food Facts 2021 and US fast-food sales data sets from QSR (Quick Service Restaurants) reports of years from 2019 to 2023 are utilized. With these data sets, the difference in advertisement types and in Black and Spanish targeted TV ads will be investigated.

## 2. Literature Review

Childhood obesity around the world, and particularly in the United States, is an escalating problem that is especially detrimental as its effects carry on into adulthood (Chou *et al.,* 2008). Chou et al. suggest that a ban on spot television fast-food restaurant advertisements would reduce the number of overweight adolescents aged 3-11 in a fixed population by 18 percent and would reduce the number of overweight adolescents ages 12-18 by 14 percent (Chou *et al.,* 2008). Such an outcome is based on data sets of 1979 Child-Young Adult National Longitudinal Survey of Youth and the 1997 National Longitudinal Survey of Youth. Some estimates suggest that the increasing prevalence of obesity accounts for approximately 300,000 deaths every year, next only to the preventable mortality associated with cigarette smoking (McGinnis and Foege 1993; Allison *et al.,* 1999). Flegal *et al.,* (2005) report a smaller but still substantial figure of approximately 112,000 excess deaths in the year 2000. Aggregate medical spending for the United States that is attribute to obesity

accounted for 9.1 percent of total annual medical expenditures in 1998, as high as $78.5 billion (Finkelstein *et al.,* 2003).

According to CDC, obesity has a high level of prevalence around 20 percent in both children and adults (Fast Food Facts 2021). Food advertising and childhood obesity, published by Ashton, concludes that advertisements targeting children have a detrimental influence on their food preferences, shopping habits, and nutritious quality they consume (Ashton, 2004). In a more recent study, Li summarized how food advertisement shift children's preference towards their products; why the shifting preferences cause children to consume more calories; Why is it so successful to prevent childhood obesity by regulating food marketing to children; why is the self-govern system not as effective as the statutory regulation when considering food marketing to children; and what are the ideas to construct a statutory regulation on food marketing to children (Li, 2002). In 2015-2018, fast food contributed 21.5% of calories consumed by non-Hispanic Black teens, 18.5% of calories consumed by Hispanic teens, and 14.8% of calories consumed by non-Hispanic White teens (Fast Food Facts 2021). Therefore, fast-food consumption among youth remains a significant public health concern (Fast Food Facts 2021). The findings in the report of Fast Food Facts 2021 demonstrate that fast-food advertising spending increased from 2012 to 2019; youth exposure to TV ads declined, but at a lower rate than reductions in TV viewing times; many restaurants continued to disproportionately target advertising to Hispanic and Black youth; and restaurants did not actively promote healthier menu items (Fast Food Facts 2021). Restaurants must do more to reduce harmful fast-food advertising to adolescents (Fast Food Facts 2021). Foods marketed to children are predominantly high in sugar and fat, and as such are inconsistent with national dietary recommendations (Poulain, 2024).

Although the relative amount of TV advertising is still predominant, fast-food chains evolved into utilizing various advertising channels, especially via digital spending for operating platforms such as Facebook, Instagram and Twitter (Torres and Lopez, 2022). Utilizing social media in digital marketing strategies has emerged as crucial factors influencing consumer buying decisions (Harun *et al.,* 2018; Lee *et al.,* 2022; Bernal-Gonzalez *et al.,* 2023; Cabrera-Cordova *et al.,* 2023; Verma *et al.,* 2023). Torres and Vega (2024) report that particularly in Colombia, fast-food chains have demonstrated exceptional effectiveness in leveraging social media as pivotal tools in their digital marketing efforts which is attributed to the strategic implementation of digital communication actions and the effective management of information technologies (Kushwaha *et al.,* 2020; Nuseir *et al.,* 2022; Molina Roncancio *et al.,* 2023; Rafael-Baltazar *et al.,* 2023).

Unfortunately, little is known about the advertising patterns of food on social media platforms (da Silva, *et al.,* 2022). Therefore, generating evidence is necessary to understand the extent of the problem of food advertising exposure and to determine appropriate and effective policy responses (Kelly *et al.,* 2013). The study of da Silva, *et al.,* (2022), after gathering social media platform advertising strategies in 2019, demonstrates that advertising patterns of the fast-food chain on three social media platforms were commonly directed to children and addressed price, discounts and the celebrities' universe. The findings of this study corroborate other data in the literature regarding unhealthy food advertising on social media, which suggests the urgency of regulating food advertising content on this medium (da Silva, *et al.,* 2022).

The study of Mkumbo and Mbise (2022) shows that 81% of the fast-food customers followed the fast-food restaurants on social media. Excessive consumption of fast food is linked to poor diet and weight outcomes in young people. On days they ate fast food, children consumed 126 additional calories and adolescents consumed 310 additional calories compared to days they did not eat fast food (Fast Food Facts 2021). Fast-food consumption also increased sugar-sweetened beverage calories and sugar and fat intake for both age groups. (Fast Food Facts 2021). In a longitudinal study with preschoolers, the number of times fast food was consumed over a year was associated with increased weight status (Emond *et al.,* 2020). Han *et al.,* (2020) suggest significant deleterious effects of proximity to fast food for student weight outcomes, with the largest effects among students in grades 3–8 attending neighborhood schools.

### 3. Data from Fast-Food Facts 2021 and QSR (Quick Service Restaurant) Report

This study adopts advertising spending and ads exposures data from 27 fast-food chains in the report of Fast Food Facts 2021. In Fast Food Facts 2021, 25 U.S. fast-food restaurants with the highest advertising spending in 2019, plus two restaurants with TV advertising targeted to children, Hispanic, and/or Black consumers are selected. U.S. sales of these 27 restaurants totaled $188 billion in 2019, an average increase of 24% over 2012 sales (Fast Food Facts 2021). The selection of 27 fast food chains was based on a non-probabilistic convenience sampling approach, as outlined in the methodology proposed by Otzen and Manterola (2017); emphasis is placed on the accessibility and relevance of sampling units rather than their representativeness

(Torres and Vega, 2024). Following Figure 1 demonstrates that TV spending is about 38 times that of digital spending.

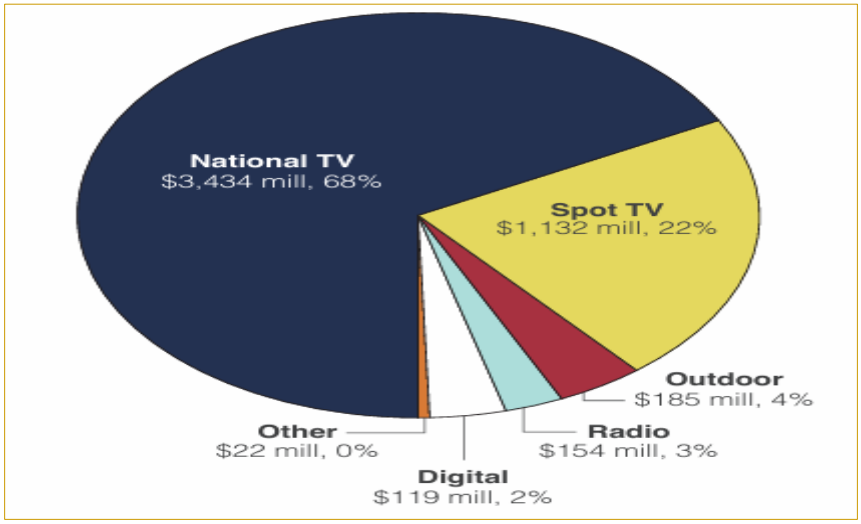


**Figure 1.** Total fast food ads spending by media type: 2019 (Source: Fast-Food Facts 2021).

**Table 1.** Descriptive statistics of fast-food ads spending: 2019.

| | TV spending ($M) | Outdoor spending ($M) | Radio spending ($M) | Digital spending ($M) |
|---|---|---|---|---|
| Valid | 28 | 28 | 28 | 28 |
| Missing | 0 | 0 | 0 | 0 |
| Mean | 163.079 | 6.621 | 5.489 | 4.264 |
| Standard deviation | 143.404 | 14.087 | 8.259 | 7.435 |
| IQR | 150.350 | 3.650 | 4.575 | 4.825 |
| Range | 612.400 | 70.400 | 33.000 | 39.200 |
| Minimum | 21.300 | 0.300 | 0.000 | 0.100 |
| Maximum | 633.700 | 70.700 | 33.000 | 39.300 |
| 25th percentile | 54.350 | 0.875 | 0.350 | 0.850 |
| 50th percentile | 130.400 | 2.200 | 2.300 | 2.050 |
| 75th percentile | 204.700 | 4.525 | 4.925 | 5.675 |

The average numbers of ads viewed are Gross Rating Points (GRPs) divided by 100. GRPs are calculated by combining the reach (percentage of the audience reached) and frequency (how many times they are exposed) to measure the total impact of the advertising (Fast Food Facts, 2013, 2021). For example, if a campaign reaches 30% of the target audience and has an average frequency of 4, the GRP would be 120% (30% X 4). Then, the number of ads viewed (exposure) is 1.2 (120%/100). In 2019, preschoolers (2-5 years) viewed on average 830 fast-food TV ads (2.3 ads-per-day). By the same procedure, TV advertising exposure by company is obtained as in the following descriptive statistics.

**Table 2.** Descriptive statistics of ads viewed.

| | 2019 preschoolers ads viewed (2-5 years) | 2019 children ads viewed (6-11 years) | 2019 teens ads viewed (12-17 years) |
|---|---|---|---|
| Valid | 27 | 27 | 27 |
| Missing | 1 | 1 | 1 |
| Mean | 30.704 | 28.770 | 27.737 |
| Standard deviation | 29.776 | 29.479 | 26.785 |
| IQR | 29.750 | 27.550 | 28.700 |
| Range | 121.800 | 127.700 | 93.900 |
| Minimum | 1.300 | 1.200 | 1.200 |
| Maximum | 123.100 | 128.900 | 95.100 |
| 25th percentile | 7.800 | 6.850 | 6.300 |
| 50th percentile | 27.200 | 26.700 | 21.700 |
| 75th percentile | 37.550 | 34.400 | 35.000 |

By applying the same procedure to Spanish-language TV and Black-targeted TV, the following tables are obtained as in Fast Food Facts 2021. Especially, exposure to Spanish-language TV ads is calculated based on the number of persons on Nielsen's viewer panel living in Hispanic households.

**Table 3.** Descriptive statistics of ads viewed by Hispanic youth.

| | **2019 Hispanic preschoolers ads viewed (2-5 years)** | **2019 Hispanic children ads viewed (6-11 years)** | **2019 Hispanic teens ads viewed (12-17 years)** |
|---|---|---|---|
| Valid | 15 | 15 | 15 |
| Missing | 13 | 13 | 13 |
| Mean | 22.807 | 16.760 | 14.020 |
| Standard deviation | 13.082 | 9.405 | 7.955 |
| IQR | 18.700 | 13.200 | 11.350 |
| Range | 44.100 | 31.100 | 26.800 |
| Minimum | 9.600 | 7.100 | 5.500 |
| Maximum | 53.700 | 38.200 | 32.300 |
| 25th percentile | 11.400 | 8.450 | 6.950 |
| 50th percentile | 19.000 | 14.300 | 11.900 |
| 75th percentile | 30.100 | 21.650 | 18.300 |

**Table 4.** Descriptive statistics of ads viewed by Black youth.

| | **2019 Black preschoolers ads viewed (2-5 years)** | **2019 Black children ads viewed (6-11 years)** | **2019 Black teens ads viewed (12-17 years)** |
|---|---|---|---|
| Valid | 22 | 22 | 21 |
| Missing | 6 | 6 | 7 |
| Mean | 46.118 | 44.564 | 45.871 |
| Standard deviation | 40.358 | 41.338 | 38.150 |
| IQR | 39.325 | 37.850 | 39.400 |
| Range | 154.600 | 167.300 | 130.600 |
| Minimum | 3.000 | 2.800 | 2.900 |
| Maximum | 157.600 | 170.100 | 133.500 |
| 25th percentile | 16.200 | 14.525 | 17.000 |
| 50th percentile | 38.900 | 36.600 | 39.900 |
| 75th percentile | 55.525 | 52.375 | 56.400 |

Moreover, as dependent variables, US sales data from 2019 to 2023 are gathered from QSR (Quick Service Restaurant) reports of each year to measure the relative importance of the explanatory variables. Descriptive statistics are in Table 5.

**Table 5**. US sales of 27 fast-food chains.

| | **Sales in millions 2019** | **Sales in millions 2020** | **Sales in millions 2021** | **Sales in millions 2022** |
|---|---|---|---|---|
| Valid | 27 | 27 | 27 | 27 |
| Missing | 1 | 1 | 1 | 1 |
| Mean | 6959.259 | 6879.889 | 7993.148 | 8551.296 |
| Standard deviation | 8068.283 | 7716.868 | 9244.938 | 10061.025 |
| IQR | 7162.500 | 6320.000 | 6704.000 | 7150.000 |
| Range | 40003.000 | 39275.000 | 45674.000 | 48394.000 |
| Minimum | 410.000 | 255.000 | 286.000 | 340.000 |
| Maximum | 40413.000 | 39530.000 | 45960.000 | 48734.000 |
| 25th percentile | 2380.000 | 2375.000 | 2897.500 | 3175.000 |
| 50th percentile | 4546.000 | 4700.000 | 5079.000 | 5087.000 |
| 75th percentile | 9542.500 | 8965.000 | 9691.500 | 10325.000 |

Recent US sales of 7 among 27 fast-food chains are plotted as the line chart of Figure 2. Figure 3 is the histogram of 2023 US sales of 27 fast-food chains. Histograms of other years are attached in the appendix. Except for 2020, US sales of most fast- food chains exhibit constantly increasing pattern.

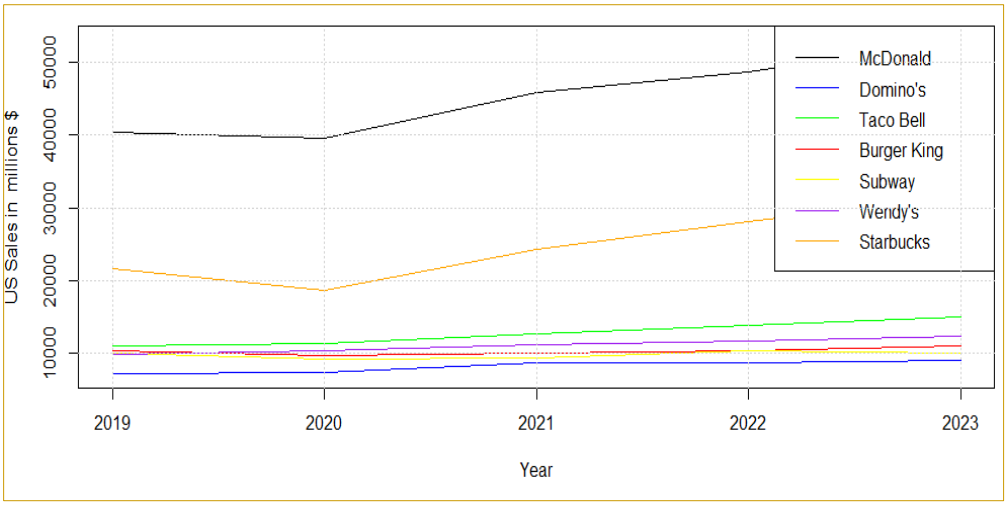


**Figure 2.** Line graph of US fast food sales by several companies.

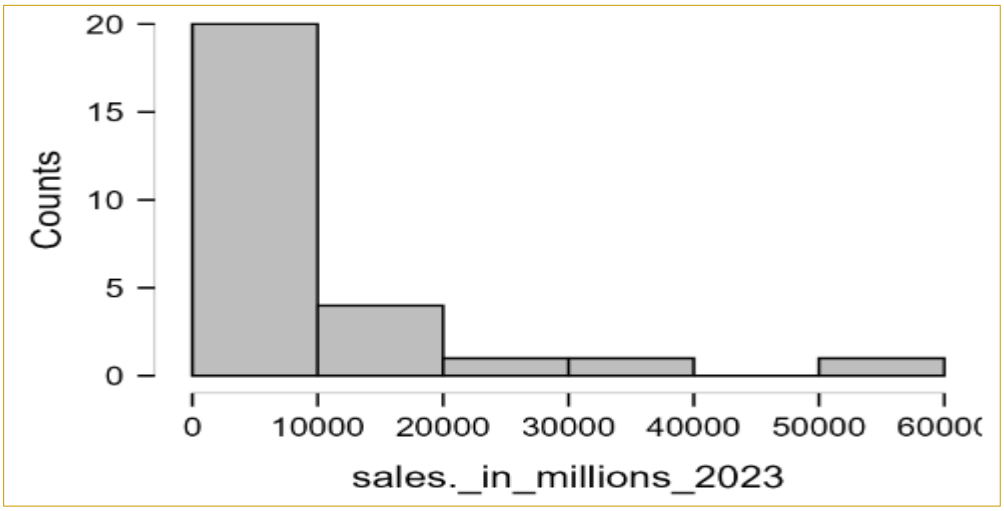


**Figure 3.** Histogram of US sales in 2023.

US sales of 27 fast-food chains reveal clear positive skewness, with McDonald an outlier. When this outlier is eliminated, linearity between the dependent and independent variables becomes weakened. Therefore, McDonald is not excluded in the subsequent analysis.

In addition to the existence of an outlier, there are several limitations of the data sets in this study. The sample size is too small (27 firms). Especially, Hispanic youth exposures are available only from 15 fast-food chains. Within these limitations of available data sets, we will search for the consistent pattern of the relation between advertisement related variables and US sales.

**4. First Inspection of Data**

As a first inspection of the variables, linear regressions of each explanatory variable are implemented. As a proxy for the impulse response of structural VAR (Vector Autoregressive), adjusted $R^2$ dynamics from linear regression models are plotted from Figure 4 to Figure 7.

Figure 4 shows that digital spending, such as web platform maintenance, social media operations like Facebook and Instagram, influencer marketing and so on, is most highly correlated with upcoming sales of firms. Given that TV advertising spending is 38 times that of digital spending, this dominance of digital spending might be somewhat unexpected. However, recent trend clearly shows that purchase intentions of customers are more and more affected by social network services, while exposures to TV ads are clearly decreasing in general. The effect of each media type, measured by adjusted $R^2$ reaches peak after one year and then diminishes constantly. According to Figure 4, it is possible that TV advertising spending is not for short run direct sales increase but for the long run enhancement of brand awareness or customer loyalty. At least in recent years, digital spending has been the predominant factor of sales increase, given simple or multiple linear regression models.

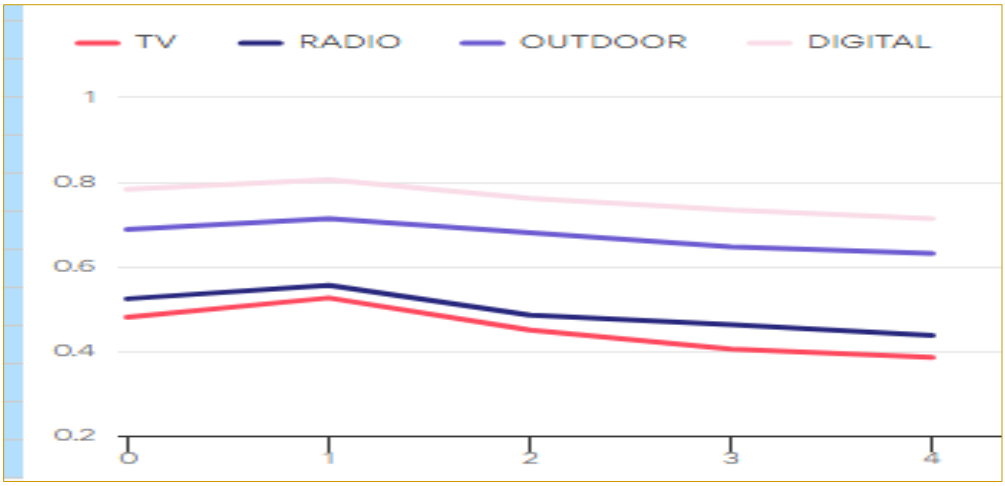


**Figure 4.** Adjusted $R^2$ dynamics by each media type.

Figure 5 demonstrates that the effect of advertisement exposures to children (6-11 years) dominates that of preschoolers (2-5 years) and teens (12-17 years), while in case of Hispanic youth, preschoolers dominate. That is, Hispanic preschoolers are more responsive to TV ads than other age groups. Except for Hispanic youth, the effects of TV advertisement exposures have a pattern of reaching peak after one year and the decreasing thereafter.

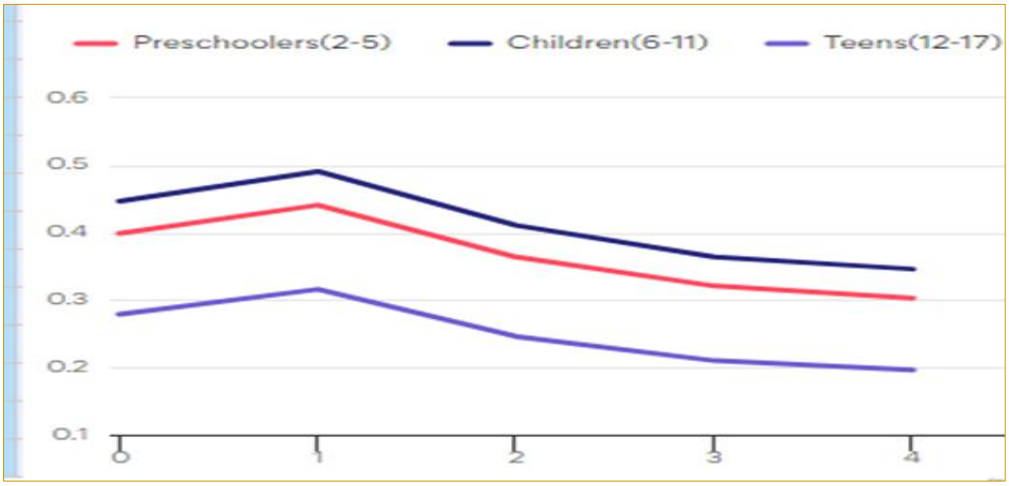


**Figure 5.** Adjusted $R^2$ dynamics of ads exposures to all youth.

According to Figure 6, the correlation between TV advertisement exposure to Hispanic youth and US sales is highest in the year 2019 and then decreases constantly, implying that purchasing intention of Hispanic youth might be more directly responsive to TV advertisement.

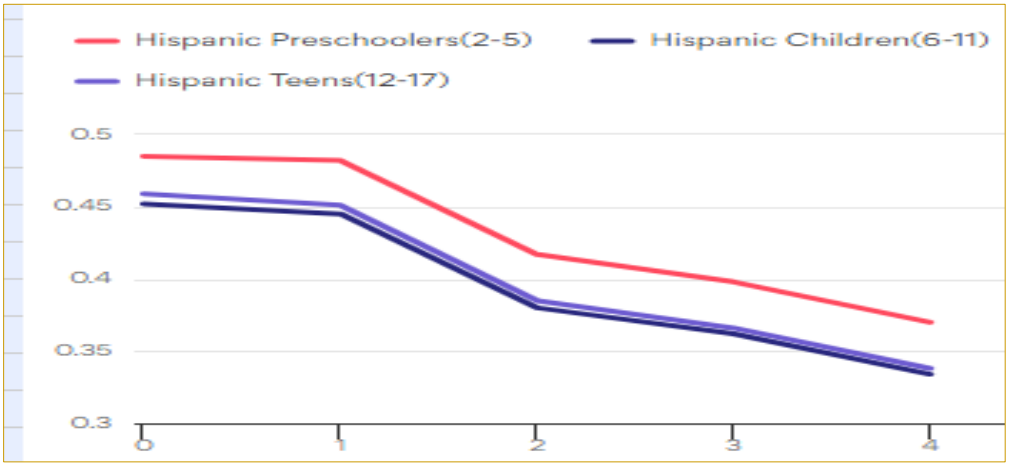


**Figure 6.** Adjusted $R^2$ dynamics of ads exposures to Hispanic youth.

As shown in Figure 7, Black youth have a similar pattern with the youth in all ethnicity groups, except for relatively lower adjusted $R^2$ in case of Black youth.

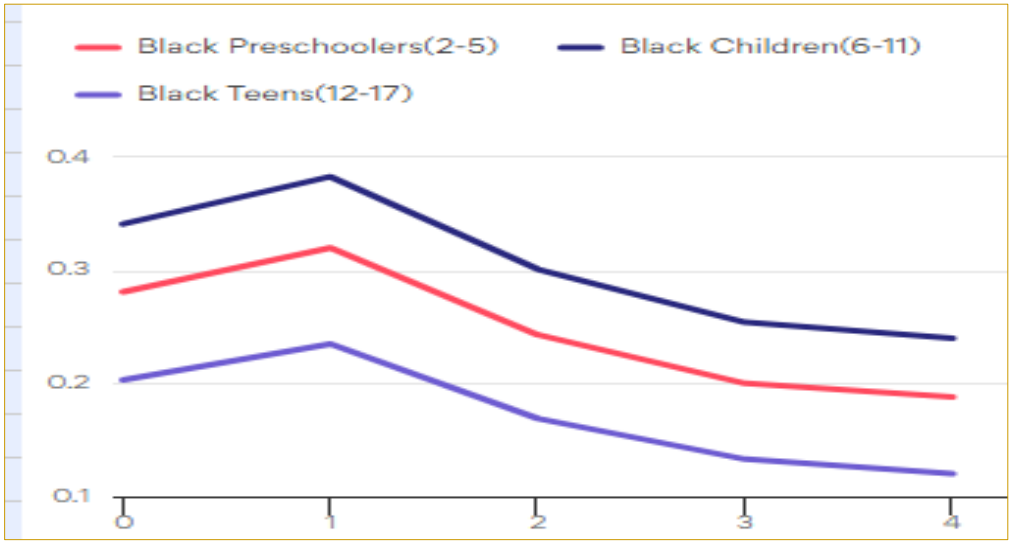


**Figure 7.** Adjusted $R^2$ dynamics of ads exposures to Black youth.

Therefore, both the relative immediacy of ads effects and the dominance of Hispanic preschoolers compared to other age groups simultaneously evoke serious health concerns, considering that many major fast-food companies have increased the Spanish-language TV and Black-targeted TV advertisement recently.

The specific adjusted $R^2$ values are added as Table 8, Table 9, Table 10, and Table 11 in appendix.

**5. Model Extension I: Dynamic Panel Data Type Approach**

Given that the dependent variable is panel data form, while independent variables are cross sectional in this study, DPD (Dynamic Panel Data) type model is more suitable than simple or multiple regression.

The following model is applied, after slight modification of DPD (Dynamic Panel Data model). Modification is from the use of three year lagged exogenous variable ($x_{it-3}$) instead of contemporary term ($x_{it}$) due to the data availability.

$$y_{it} = \alpha + \rho_1 y_{it-1} + \rho_2 y_{it-2} + \rho_3 y_{it-3} + \beta x_{it-3} + u_i + \varepsilon_{it}$$

US sales data up to three year lagged values are selected since it gives the best fit. Normally, differenced data values are used to eliminate the firm specific error term $u_i$ and the intercept term. But since differenced data for exogenous explanatory variables ($\Delta x_{it}$) are not available, we assumed that the effect of firm specific error terms ($u_i$) are included in the error term ($\varepsilon_{it}$).

For example, in case where $x_{it-3}$ designates 2019 TV ads spending, estimated model is:

$$\text{US sales}_{2022}$$

$$= 134.774 \quad (111.038)$$

$$+ 1.241\text{US sales}_{2021} \quad (0.082)$$

$$- 0.450\text{US sales}_{2020} \quad (0.190)$$

$$+ 0.280\text{US sales}_{2019} \quad (0.137)$$

$$- 2.258\text{TV spending}_{2019} \quad (1.073)$$

The summary statistics for this exogenous variable are given as Table 12 in appendix. The output table from each exogenous variable is summarized as Table 6.

According to the above Table 6, TV spending and average number ads viewed by all groups except for Hispanic youth have significantly negative impact on future sales. However, the negative impacts on future sales of digital spending and average number ads viewed by youth are not significant.

This result casts two questions: Firstly, why are fast-food chains spending a substantial amount on TV advertisements, even though it has a clearly negative effect on future sales? Secondly, why are the exposures to Hispanic youth exposing different pattern from Black youth or all youth inclusive?

Although the reason why fast-food chains are implementing such seemingly unreasonable spending is not clear in this study, fast-food chains might seek long-run brand awareness or customer loyalty, regardless of the short-run detrimental impact on current and future sales. But when reminding the fact that TV exposures have broadly decreased from 2012 to 2019 (Fast Food Facts 2013, 2021) while the sum of US sales has increased 24% during the same period, this negative correlation between TV advertising spending and US sales is not very surprising.

Moreover, the discrepancy between Hispanic youth and Black youth or all youth inclusive cannot be clearly explained in this study due to the limitations of available data sets.

**Table 6.** Outcome of dynamic panel data analysis.

| $x_{it-3}$ | Coefficient | Standard error | t | P-value | Significant or not |
|---|---|---|---|---|---|
| TV spending | -2.258 | 1.073 | -2.106 | 0.047 | *** |
| Outdoor spending | -21.204 | 11.386 | -1.862 | 0.076 | ** |
| Radio spending | 18.284 | 18.740 | 0.976 | 0.340 | Not |
| Digital spending | -25.623 | 26.259 | -0.976 | 0.340 | Not |
| 2019 preschoolers ads viewed | -11.06 | 4.532 | -2.440 | 0.023 | *** |
| 2019 children ads viewed | -14.121 | 4.748 | -2.974 | 0.007 | *** |
| 2019 teens ads viewed | -8.762 | 4.635 | -1.890 | 0.072 | ** |
| 2019 Hispanic preschoolers ads viewed | -7.988 | 15.281 | -0.523 | 0.513 | Not |
| 2019 Hispanic children ads viewed | -9.758 | 20.740 | -0.470 | 0.648 | Not |
| 2019 Hispanic teens ads viewed | -13.442 | 24.747 | -0.543 | 0.599 | Not |
| 2019 Black preschoolers ads viewed | -9.328 | 3.538 | -2.637 | 0.017 | *** |
| 2019 Black children ads viewed | -10.808 | 3.567 | -3.030 | 0.008 | *** |
| 2019 Black teens ads viewed | -8.291 | 3.715 | -2.232 | 0.040 | *** |

## 6. Model Extension II: Principal Component Analysis

To check whether the previous result can be consistently observed in the other context, PCA (Principal Component Analysis) is added. The variability of all 18 variables is summarized along two principal components. The first component captures 82.9% of all variations. The second component captures 11% of variations. Component loadings are in Table 7. Biplot is given in Figure 8.

**Table 7.** Component loadings (blue colors for the values above 0.2).

| | Comp.1 | Comp.2 |
|---|---|---|
| 1. Sales 2019 | 0.24590674 | 0.12345427 |
| 2. Sales 2020 | 0.22811115 | 0.15192340 |
| 3. Sales 2021 | 0.26730916 | 0.17644178 |
| 4. Sales 2022 | 0.28857791 | 0.16654658 |
| 5. Sales 2023 | 0.29471489 | 0.18581153 |
| 6. 2019 preschoolers ads viewed (2-5 years old) | -0.24161988 | 0.19696802 |
| 7. 2019 children ads viewed (6-11 years old) | -0.21819453 | 0.16960023 |
| 8. 2019 teens ads viewed (12-17 years old) | -0.32020558 | 0.18119407 |
| 9. 2019 Hispanic preschoolers ads viewed | -0.04167674 | -0.43687796 |
| 10. 2019 Hispanic children ads viewed | -0.03983798 | -0.48148784 |
| 11. 2019 Hispanic teens ads viewed | -0.03826499 | -0.47778417 |
| 12. 2019 Black preschoolers ads viewed | -0.30997667 | 0.10642303 |
| 13. 2019 Black children ads viewed | -0.27261015 | 0.11210190 |
| 14. 2019 Black teens ads viewed | -0.35431089 | 0.14694124 |
| 15. 2019 TV spending($M) | -0.18846154 | 0.04416887 |
| 16. 2019 Outdoor spending($M) | 0.19876666 | 0.06008757 |
| 17. 2019 Radio spending($M) | 0.09705450 | -0.25390005 |
| 18. 2019 Digital spending($M) | 0.22850494 | 0.03754098 |

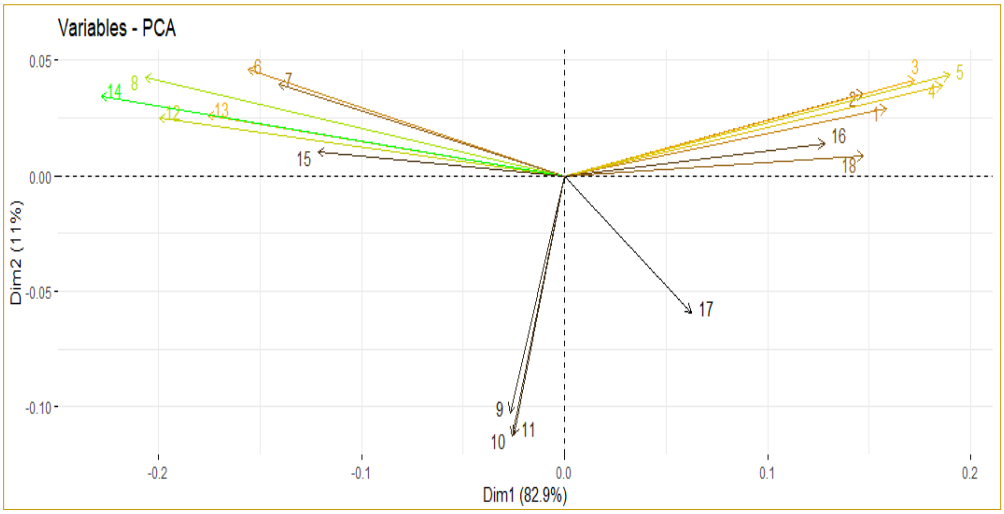


**Figure 8.** Biplot of PCA.

1) Sales 2019; 2) Sales 2020; 3) Sales 2021; 4) Sales 2022; 5) Sales 2023; 6) 2019 preschoolers ads viewed (2-5 years old); 7) 2019 children ads viewed (6-11years old); 8) 2019 teens ads viewed (12-17 years old); 9) 2019 Hispanic preschoolers ads viewed; 10) 2019 Hispanic children ads viewed; 11) 2019 Hispanic teens ads viewed; 12) 2019 Black preschoolers ads viewed; 13) 2019 Black children ads viewed; 14) 2019 Black teens ads viewed; 15) 2019 TV spending($M); 16) 2019 Outdoor spending($M); 17) 2019 Radio spending($M); 18) 2019 Digital spending($M)

Scree plot (Figure 13), and the contributions of each variable (Figure 14, Figure 15) are in appendix.

Several implications from the above biplot are:

1) Digital spending and outdoor spending are positively correlated with current and future sales.
2) The relative contribution of digital spending on the first principal component is greater than that of outdoor spending.
3) Ads exposures to Hispanic youth have different pattern from those to the Black youth or all youth.
4) Average number of ads viewed by Black teens, Black preschoolers, Black preschoolers along with teens, preschoolers and children in general are all positively correlated with TV spending and negatively correlated with current and future sales.
5) The contribution of ads exposures to Black youth on the first component is greater than that of all youth.
6) The negative correlation between TV advertising spending and current and future US sales in addition to the positive correlation between digital spending and US sales consist of the most variation of all variables (82.9%).
7) Exposures of Hispanic youth to ads are negatively correlated with US sales.
8) Exposures of Hispanic youth to ads are almost uncorrelated with TV spending and exposures to Black youth or all youth.
9) The negative correlation between exposures to Hispanic youth and US sales is weaker than that of Black youth or all youth.
10) The positive correlation between exposures to Hispanic youth and Radio spending composes most of the second principal component. (11.1%).

## 7. Conclusion

The average number of ads viewed by youth has decreased from 2012 to 2019, but Spanish-language TV ads spending has increased. Increases in exposure to fast-food TV ads by Black relative to White youth raise concerns. During the same periods, both the total advertising spending and US sales of fast-food chains have increased.

Digital spending is positively correlated with current and future US sales of fast-food chains. However, both TV advertising spending and exposures of ads to youth are negatively correlated with these sales. Although the specific meaning of principal component is not admitted, more direct purchase intentions seem to be linked with digital spending and US current and future sales. Likewise, TV spending and TV ads exposures to all youth or Black youth can be more related with indirect brand awareness or customer loyalty within existing markets than with direct sales boost.

Along with this interpretation, exposures of Hispanic youth to ads play a special role, since this variable is negatively correlated with US sales and is almost uncorrelated with TV spending. Increase in Spanish-language TV ads and exposures of Hispanic youth to ads might be a new market penetration or a market opening in the perspective of fast-food companies. Therefore, the first principal component might be interpreted as an already existing market environment encompassing purchase intentions and brand awareness. The second principal component would be approximated as a new market environment ready to be opened or penetrated.

In 2024, global digital ad spending reached $740.3 billion, a 8.9% increase from 2023. This noticeable increase in digital spending such as marketing through social network services necessitates different perspectives of regulations. Moreover, increase in Spanish-language or Black-targeted TV advertisement requires more concerns about childhood obesity. Typical patterns inherent in exposures to Hispanic youth, dominance of preschoolers and immediacy of responses, can be more detrimental to childhood health. However, publicly accessible data sets for these investigations are quite limited. In this respect, establishing more reliable and complete data sets regarding online platform advertisements or Spanish-targeted or Black-targeted TV is inevitable to understand the extent of the problem of food advertising exposure and to determine appropriate and effective policy responses.

**Declarations**

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**APPENDIX**

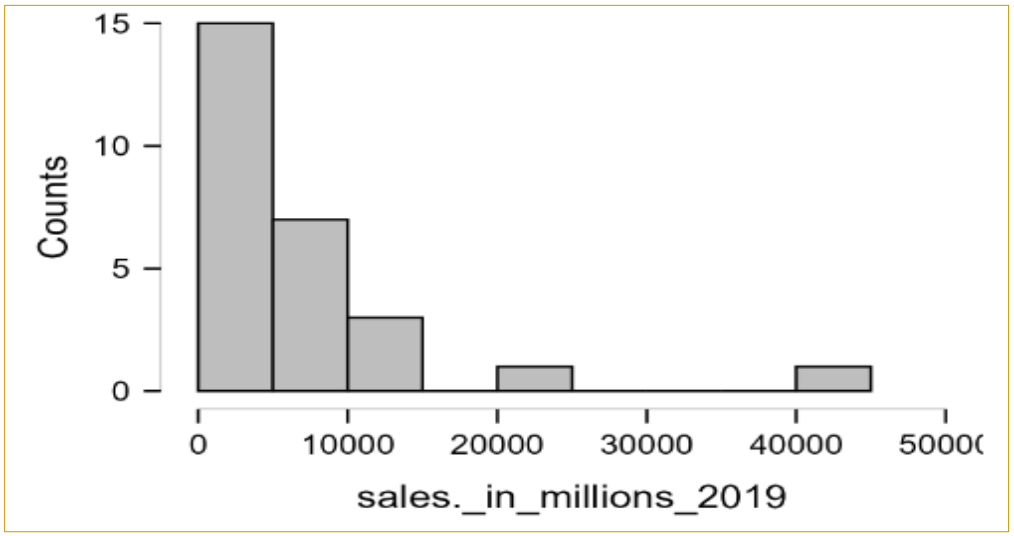


**Figure 9.** Histogram of US sales in 2019.

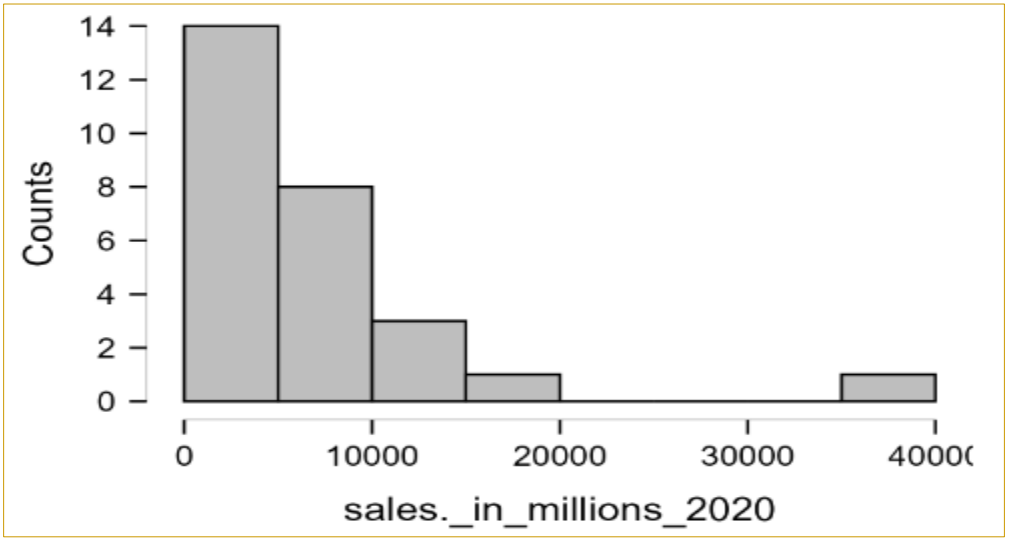


**Figure 10.** Histogram of US sales in 2020.

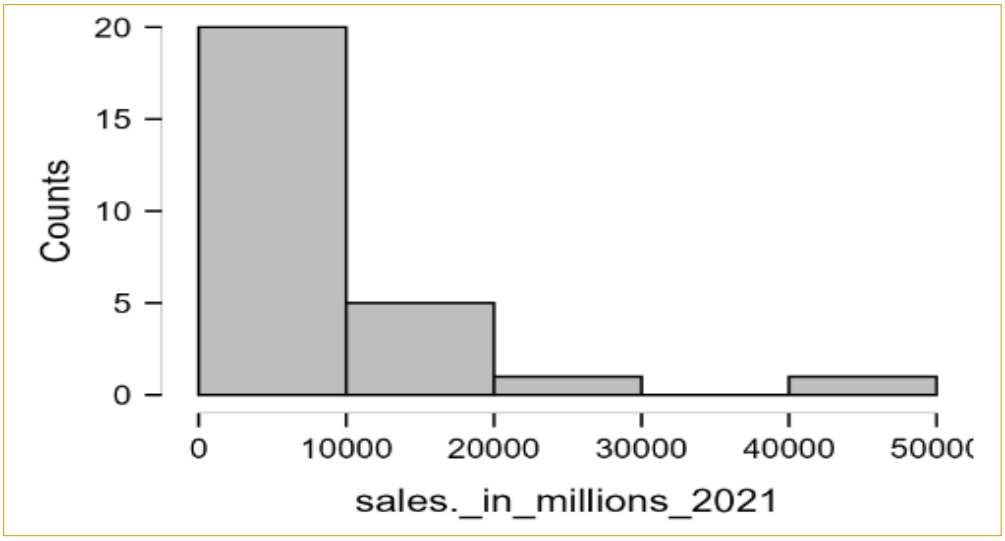


**Figure 11.** Histogram of US sales in 2021.

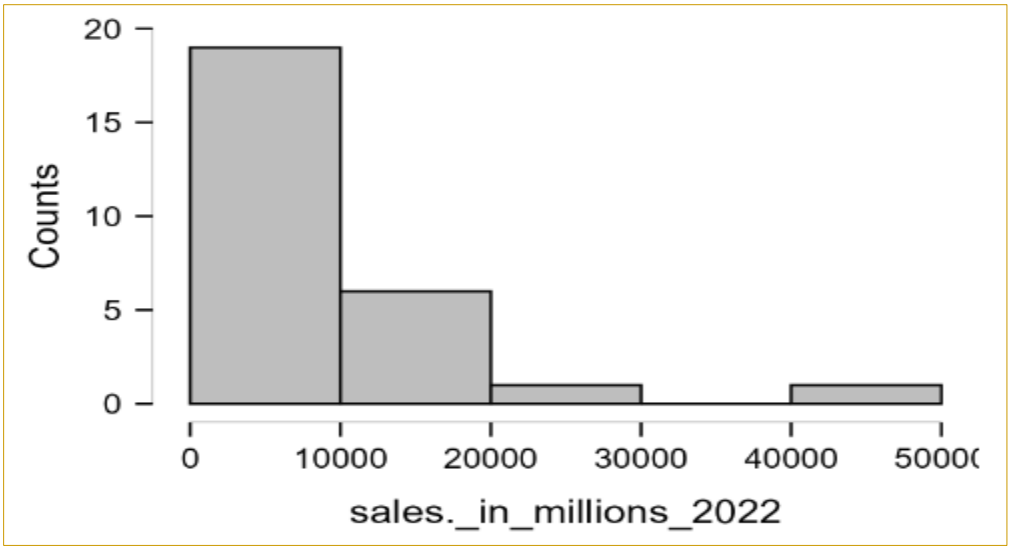


**Figure 12.** Histogram of US sales in 2022.

**Table 8.** Adjusted R-squared values by media type.

| | TV (2019) | Radio (2019) | Outdoor (2019) | Digital (2019) |
|---|---|---|---|---|
| 2019 | 0.48 | 0.524 | 0.688 | 0.783 |
| 2020 | 0.526 | 0.556 | 0.714 | 0.806 |
| 2021 | 0.45 | 0.485 | 0.680 | 0.762 |
| 2022 | 0.405 | 0.463 | 0.647 | 0.734 |
| 2023 | 0.385 | 0.437 | 0.631 | 0.714 |

**Table 9.** Adjusted R-squared values by ads exposures of youth in general.

| | Preschoolers (2-5) | Children (6-11) | Teens (12-17) |
|---|---|---|---|
| 2019 | 0.399 | 0.447 | 0.279 |
| 2020 | 0.441 | 0.491 | 0.316 |
| 2021 | 0.364 | 0.411 | 0.246 |
| 2022 | 0.321 | 0.364 | 0.210 |
| 2023 | 0.303 | 0.346 | 0.196 |

**Table 10.** Adjusted R-squared values of ads exposures by Hispanic youth.

| | Hispanic preschoolers (2-5) | Hispanic children (6-11) | Hispanic teens (12-17) |
|---|---|---|---|
| 2019 | 0.485 | 0.452 | 0.459 |
| 2020 | 0.482 | 0.445 | 0.451 |
| 2021 | 0.417 | 0.380 | 0.385 |
| 2022 | 0.398 | 0.362 | 0.366 |
| 2023 | 0.370 | 0.334 | 0.338 |

**Table 11.** Adjusted R-squared values of ads exposures by Black youth.

| | Black preschoolers (2-5) | Black children (6-11) | Black teens (12-17) |
|---|---|---|---|
| 2019 | 0.281 | 0.341 | 0.203 |
| 2020 | 0.320 | 0.383 | 0.235 |
| 2021 | 0.243 | 0.301 | 0.169 |
| 2022 | 0.200 | 0.254 | 0.133 |
| 2023 | 0.188 | 0.240 | 0.120 |

**Table 12.** Outcome table of dynamic panel data analysis with TV spending amount.

| **Model summary-sales in millions 2022** | | | | | | |
|---|---|---|---|---|---|---|
| **Model** | | **R** | **$R^2$** | **Adjusted $R^2$** | **RMSE** | |
| $M_0$ | | 0.000 | 0.000 | 0.000 | 10061.025 | |
| $M_1$ | | 0.999 | 0.999 | 0.999 | 377.066 | |
| Note: M1 includes sales in millions 2021; sales in millions 2020; sales in millions 2019, TV spending ($M) | | | | | | |
| **ANOVA** | | | | | | |
| **Model** | | **Sum of squares** | **df** | **Mean square** | **F** | **p** |
| $M_1$ | Regression | $2.629 \times 10^{+9}$ | 4 | $6.572 \times 10^{+8}$ | 4622.169 | <.001 |
| | Residual | $3.128 \times 10^{+6}$ | 22 | 142179.018 | - | - |
| | Total | $2.632 \times 10^{+9}$ | 26 | - | - | - |
| Note: M1 includes sales in millions 2021; sales in millions 2020; sales in millions 2019, TV spending ($M) | | | | | | |
| Note: The intercept model is omitted, as no meaningful information can be shown. | | | | | | |
| **Coefficients** | | | | | | |
| **Model** | | **Unstandardized** | **Standard error** | **Standardized** | **t** | **p** |
| $M_0$ | (Intercept) | 8551.296 | 1936.245 | - | 4.416 | <.001 |
| $M_1$ | (Intercept) | 134.774 | 111.038 | - | 1.214 | 0.238 |
| | Sales in millions 2021 | 1.241 | 0.082 | 1.140 | 15.228 | <.001 |
| | Sales in millions 2020 | -0.450 | 0.190 | -0.345 | -2.367 | 0.027 |
| | Sales in millions 2019 | 0.280 | 0.137 | 0.224 | 2.040 | 0.054 |
| | TV spending ($M) | -2.258 | 1.073 | -0.032 | -2.106 | 0.047 |

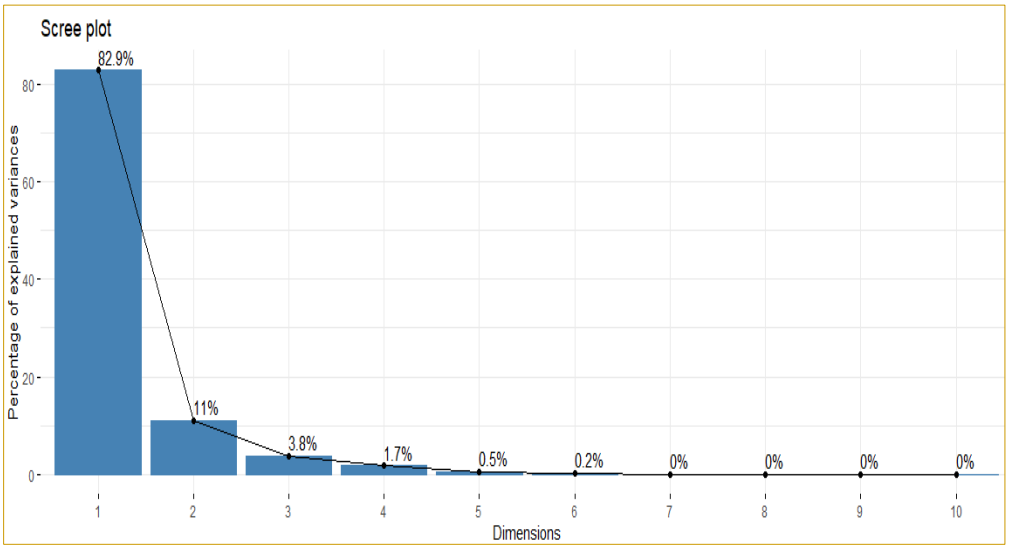


**Figure 13.** Scree plot of PCA.

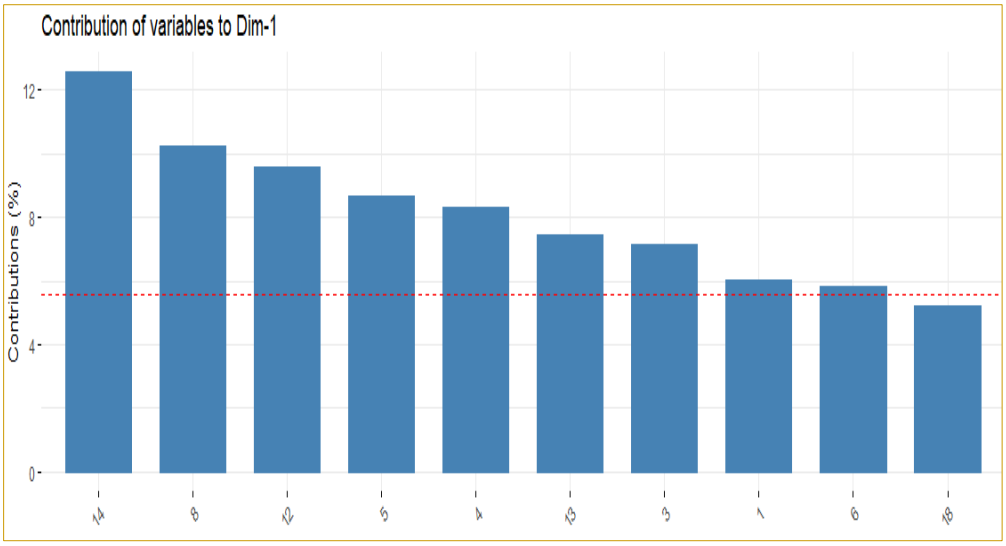


**Figure 14.** Contribution of each variable to the first principal component.

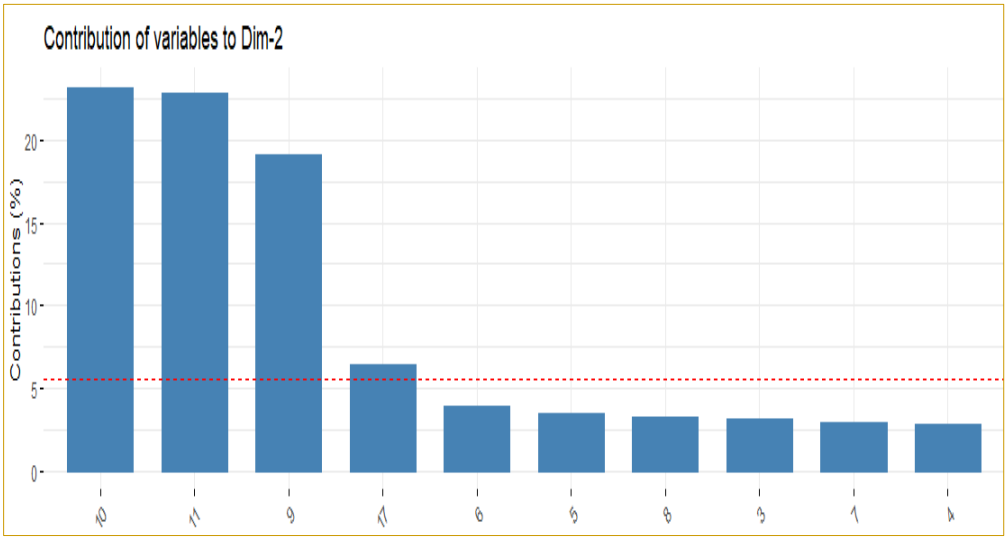


**Figure 15.** Contribution of each variable to the second principal component.