Assignment

Advertising Investment and Exposure

Assume that you are a marketing executive of our firm and you are interested in the efficiency of the firm’s expenditures on advertising transform into actual exposure. The advertising investment (in million dollars) and exposure (in billion person-times) of the past 4 years in 3 main markets of the firm are summarized in the following table. Note that the advertising exposure in country C is severely affected by a sudden pandemic in year 2020, please exclude this sample in your regression.

|  |  |  |  |
| --- | --- | --- | --- |
| Country | Year | Ad. Investment | Ad. Exposure |
| A | 2018 | 11 | 171.7 |
| 2019 | 20 | 241.2 |
| 2020 | 18 | 199.5 |
| 2021 | 26 | 338.6 |
| B | 2018 | 62 | 3204.3 |
| 2019 | 75 | 4062.3 |
| 2020 | 69 | 1305.6 |
| 2021 | 57 | 2712.1 |
| C | 2018 | 39 | 1021.4 |
| 2019 | 41 | 1142.3 |
| 2020 | 50 | 1317.2 |
| 2021 | 31 | 797.7 |

1. Draw the scatter diagram: *Ad. Exposure* as the dependent variable and *Ad. Investment* as the independent variable. Determine the regression models henceforth with OLS in **Excel**.
   1. Estimate the linear regression function . What is the advertising exposure in country C in 2020 implied by your result if the pandemic did not happen?
   2. Estimate the quadratic regression function . What is the advertising exposure in country C in 2020 implied by your result if the pandemic did not happen?
   3. Compare the two regression functions. Which fits the observed data better? How you draw this conclusion? Can incorporating a cubic term () further improve the fitting performance? Verify your answer without actually conducting the regression.
2. A supplementary material provides the total advertisement exposure capacity (*Market Size*, in million person-times) each country can provide per year. You calculate the advertisement coverage (*Ad. Coverage* *Ad. ExposureMarket Size*) as summarized the following table.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Country | Year | Ad. Investment | Ad. Exposure | Market Size | Ad. Coverage |
| A | 2018 | 11 | 171.7 | 1422.4 | 12.07% |
| 2019 | 20 | 241.2 | 16.96% |
| 2020 | 18 | 199.5 | 14.03% |
| 2021 | 26 | 338.6 | 23.80% |
| B | 2018 | 62 | 3204.3 | 7704.8 | 41.59% |
| 2019 | 75 | 4062.3 | 52.72% |
| 2020 | 69 | 1305.6 | 16.95% |
| 2021 | 57 | 2712.1 | 35.20% |
| C | 2018 | 39 | 1021.4 | 3499.6 | 29.19% |
| 2019 | 41 | 1142.3 | 32.64% |
| 2020 | 50 | 1317.2 | 37.64% |
| 2021 | 31 | 797.7 | 22.79% |

* 1. Draw the scatter diagram with *Ad. Coverage* as the new dependent variable. Which do you think is more proper, the linear or the quadratic form? Verify your answer.
  2. Estimate a linear regression function as in question 1a with *Ad. Coverage* as the new dependent variable. What is the advertising coverage in country C in 2020 implied by your result if the pandemic did not happen?
  3. What is the potential defect of the linear form (especially when the dependent variable is in percentage)? Come up with a method to alleviate (or resolve if possible) such defect.

1. The marketing manager in charge of country C provides a detailed table containing seasonal data of the past 4 years as summarized below. (Given that you concentrate on a single market now, it’s no longer necessary to adjust the data with market size.)

|  |  |  |  |
| --- | --- | --- | --- |
| Year | Season | Ad. Investment | Ad. Exposure |
| 2018 | 1 | 6.2 | 152.5 |
| 2 | 10.9 | 384.8 |
| 3 | 10.1 | 292.7 |
| 4 | 11.8 | 191.4 |
| 2019 | 1 | 10.5 | 301.5 |
| 2 | 11.2 | 400.3 |
| 3 | 9.7 | 299.5 |
| 4 | 9.6 | 141.0 |
| 2020 | 1 | 11.7 | 313.2 |
| 2 | 12.1 | 415.8 |
| 3 | 13.9 | 384.4 |
| 4 | 12.3 | 203.8 |
| 2021 | 1 | 7.1 | 182.0 |
| 2 | 8.1 | 307.2 |
| 3 | 7.6 | 215.1 |
| 4 | 8.2 | 93.4 |

* 1. Can the simple regression function with *Ad. Investment* as the only independent variable accurately predict the advertising exposure of each season in country C? If not, try to separate the seasonal-specific impacts from the observed exposure data.
  2. Last month, management of the firm adopted an advertising budget of 6.7 million dollars in country C for the 2nd season of 2022. Predict the exposure.
  3. Compare the results with regard to *how expenditures on advertising affect exposure in country C on average* in question 2b and 3a. How may you explain the discrepancy?

1. The seasonal data of the past 4 years in country B is summarized as below. You want to identify whether the relationship between advertising investment and exposure is reshaped **since** the pandemic. You are clear that the seasonality of this market is intrinsic and uncorrelated to the pandemic, thus you can safely assume **identical** seasonal fixed-effects across years.

|  |  |  |  |
| --- | --- | --- | --- |
| Year | Season | Ad. Investment | Ad. Exposure |
| 2018 | 1 | 13.9 | 633.6 |
| 2 | 17.1 | 1132.3 |
| 3 | 16.1 | 887.7 |
| 4 | 14.9 | 550.7 |
| 2019 | 1 | 17.6 | 891.2 |
| 2 | 22.2 | 1442.6 |
| 3 | 19.7 | 1095.6 |
| 4 | 15.5 | 632.9 |
| 2020 | 1 | 18.0 | 305.9 |
| 2 | 19.3 | 564.5 |
| 3 | 17.4 | 358.0 |
| 4 | 14.3 | 77.2 |
| 2021 | 1 | 12.2 | 601.5 |
| 2 | 16.3 | 919.6 |
| 3 | 14.8 | 728.5 |
| 4 | 13.7 | 462.5 |

Try to identify the impact(s) of the pandemic. (Not necessarily one-fold or only temporary.)