

Bias in the Calculation of Marketing ROI

A White Paper



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Background

The most common calculation of ROI in marketing mix models depends on using a per unit profit calculation where costs are averaged over total volume.

$$\text{Advertising ROI} = \frac{V_A * (p - c_m - c_A^* - c_T^*)}{C_A} \quad (1)$$

where V_A is the incremental volume due to advertising, p is the per unit price to retailer, c_m is the per-unit manufacturing cost and C_A is the total cost of advertising.

The terms c_A^* and c_T^* are the per unit costs of advertising and trade (merchandising) calculated by dividing the total cost by the total number of units sold, V_{TOT} . In other words:

$$c_A^* = \frac{C_A}{V_{TOT}} \quad \text{and} \quad c_T^* = \frac{C_T}{V_{TOT}} \quad (2)$$

ROI from an Incremental Volume Perspective

Instead of using V_{TOT} and dividing by all units sold, we could develop per unit costs based only on the incremental volume generated as follows:

$$c_A = \frac{C_A}{V_A} \text{ and } c_T = \frac{C_T}{V_T},$$

and if $V_B = \text{baseline sales}$ then

$$V_{TOT} = V_B + V_A + V_T \quad (3)$$

where V_A is the incremental volume due to advertising (introduced above) and V_T is the incremental volume due to trade.

Defining per unit costs from the perspective of incremental volume is more defensible because the cost of generating the incremental volume is associated with the incremental volume and not with other “baseline” units that did not require that cost. However, the calculation will lead to much higher per-unit advertising and trade costs because V_A and V_T are smaller than the standard denominator, V_{TOT} .

“Defining per unit costs from the perspective of incremental volume is more defensible ...”

The use of c_A and c_T as opposed to the more common c_A^* and c_T^* is motivated by looking at the calculation of the total incremental margin (not a per unit basis):

$$(V_A + V_T) * (p - c_m) - C_A - C_T \quad (4)$$

Using the definition above, equation (4) can be decomposed into the sum of the incremental margin due to advertising and the incremental margin due to trade:

$$\begin{aligned} (V_A + V_T) * (p - c_m) - C_A - C_T \\ = V_A * (p - c_m - c_A) + V_T * (p - c_m - c_T) \end{aligned} \quad (5)$$

If we divide the incremental margin due to advertising (trade) by the total cost of advertising (trade), we get the definitions of ROI:

$$\begin{aligned} \text{Advertising ROI} &= \frac{V_A * (p - c_m - c_A)}{C_A} \\ \text{Trade ROI} &= \frac{V_T * (p - c_m - c_T)}{C_T} \end{aligned} \quad (6)$$

Comparison with Traditional Measures of ROI

It is useful to compare this to what we get if we use the common definition of incremental margin corresponding to equation (1). The standard definition of incremental margin due to advertising and trade are:

$$V_A * (p - c_m - c_A^* - c_T^*) \quad \text{and} \quad V_T * (p - c_m - c_A^* - c_T^*)$$

Note that the costs for advertising and trade are present in both terms. The asterisk (as defined above) indicates that the costs are divided by the total volume.

If we include the standard costs, this gives us the standard definition of “profit per unit” based on the typical kinds of aggregate financial data available. However, these two terms do not sum to the total incremental margin. Instead:

$$\begin{aligned} &V_A * (p - c_m - c_A^* - c_T^*) + V_T * (p - c_m - c_A^* - c_T^*) = \\ &(V_A + V_T) * (p - c_m) - \frac{(V_A + V_T)}{V_{TOT}} * (C_A + C_T) \end{aligned}$$

Thus, the standard method will *overestimate* the total incremental margin whenever $V_A + V_T < V_{TOT}$ or equivalently whenever the baseline volume is large relative to the incremental volume.

In addition the individual terms for incremental margin due to advertising and incremental margin due to trade will also be overestimated, as will ROI. To see this for advertising, note that the ratio for the incorrect (larger) versus correct (smaller) ROI is:

$$\text{Ratio of ROI} = \frac{V_A * (p - c_m - c_A^* - c_T^*) / C_A}{V_A * (p - c_m - c_A) / C_A} = \frac{p - c_m - c_A^* - c_T^*}{p - c_m - c_A}$$

So, the ROI for advertising will be overstated whenever $c_A > c_A^* + c_T^*$, or equivalently whenever the contribution from advertising is less than advertising’s share of total costs:

“... the standard method [of calculating ROI] will overestimate the total incremental margin whenever ... the baseline volume is large relative to the incremental volume.”

$$\frac{V_A}{V_{TOT}} < \frac{C_A}{C_A + C_T}$$

A similar inequality holds for trade:

$$\frac{V_T}{V_{TOT}} < \frac{C_T}{C_A + C_T}$$

If trade costs are removed from the profit component of the advertising ROI calculation, then that corresponds to a condition where $c_A > c_A^*$ or where the contribution from advertising $V_A/V_{TOT} < 1$.

Conclusion

By using a common profit term for each element of the marketing mix and by not correctly allocating costs in the profit calculations, the common definition and calculation of ROI will be biased by a large amount.

ROI will be *overstated* when the baseline volume is larger than the incremental volume (which is usually the case) and when the

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contribution of the mix element is less than its share of spending (which is typical for TV). ROI will be *understated* when the contribution of a mix element is large relative to its share of spending (which is typical for digital media).

The potential bias in calculating ROI is not trivial.

If contribution of advertising is 12% of total volume and its cost represents 50% of DME plus trade promotion expense, then the ROI could be overstated by as much as a factor of 8. Furthermore, if trade represents about an 20% contribution and its costs are removed from the profit component, then the overstatement bias will increase to a factor of 9.

Using the “standard” definition of profit and applying it to each marketing mix element does not enable us to recover the total marginal contribution of advertising and trade from the per unit marginal contributions. The standard profit definition leads to biased ROI because the cost of generating incremental sales is distributed over sales and profits that have nothing to do with those incremental sales.

The overestimation is particularly high for advertising, where the share of spending can exceed the contribution by a large factor and may be underestimated for online marketing where the share of spend is often less than the contribution.

Correct assignment of per unit costs leads to lower advertising ROIs yet puts more emphasis on establishing the value of the long term return of advertising versus the short term.