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A STUDY OF BASELINE ESTIMATES

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A Study of Baseline Estimates

What is baseline volume?

It is the normal expected volume for the product in absence of any store level promotional activity, such as feature ads, price reductions, or displays, for that product. It is an estimate of sales calculated at a UPC level on a weekly basis for each individual store.

Baseline estimates are generated using the Box-Jenkins time series expectation of non-promoted volume calculated at the store/week/UPC level. The expectation of sales is a weighted moving average of weekly observations of normal non-promoted volume. The simple approximation of the baseline calculation is

Current base b_t = previous sales $y_{t-1} - \gamma$*(previous sales y_{t-1} – previous base b_{t-1}),

where γ is a smoothing parameter. If previous sales are promoted, then current base b_t = previous base b_{t-1}.

Or one can write the calculation as

$$b_t = y_{t-1} - \gamma(y_{t-1} - b_{t-1}), \text{ or}$$
$$b_t = (1 - \gamma)\sum_{n=0}^{t} \gamma^{n-1} y_{n-1} + \gamma^t b_0.$$

As shown in the equation above, the baseline volume is a geometric mean of past sales and initial baseline volume. The baseline volume calculations use the data for the most recent 17 weeks for an eight-week update. Short and long sales thresholds are created to identify data outliers. Long sales are defined as a condition where sales are greater than 2.0 times the centered preliminary baseline. This condition assumes an unknown causal event occurred. Short sales are defined as condition where sales are less than 0.35 times of the center preliminary baseline. This condition assumes a negative event such as an out-of-stock occurred.

The incremental volume is the portion of total volume exceeding expected volume, i.e., baseline volume. The incremental volume has been used to represent the additional volume resulting from trade promotions, such as feature ads, display and temporary price reduction (TPR).

Promotional activities and their measurements

There are three major types of retail promotional activities: feature advertising, displays, and temporary price reduction. Feature advertising has been a common practice of food retailers. Feature advertising includes retailer specific best-food-day advertising,

store flyers, circulars, and other materials. Most of the retailers' advertisings are brand specific with some being major while others are line ads. Free standing inserts are not included because they are not retailer specific.

In-store display is another method that has been used by retailers to promote their brands or products. Promotional displays include the display of the products in secondary locations, cut cases placed next to regular shelf location, and those displays in primary locations but with special efforts. Displays give the product of interest more visibility and may increase the sales of the product. Most times feature advertising and displays come with price reductions.

Temporary price reduction (TPR) is a price decrease of greater than 5% of the regular price. The regular price is the median of all prices within 5% of the maximum price in the previous seven weeks.

Percent of all commodity volume (ACV) that had the promotional activity is used to measure the intensity of the promotion. The available measurements of promotional activities are %ACV which had feature ads only, displays only, feature ads and displays, and TPR only. The %ACV for promotional activities are calculated at a UPC level on a weekly basis for each individual store.

The relationship between baseline volume and promotional activities

The relationship between baseline volume and promotional activities was examined using the ordinary least squares method. It is assumed that the baseline volume is a function of the price of the product of interest, seasonality, a time trend, and %ACV of the promotional activity. Since the baseline volume is the normal expected volume for the product in the absence of any store level promotional activity, one would expect the coefficient estimate for the %ACV to be statistically insignificant.

Four sets of relationships were examined: feature ad baseline volume and %ACV for feature ads; display baseline volume and %ACV for displays; feature ad and display baseline volume and %ACV for feature ads and displays; TPR baseline volume and %ACV for TPR. The volumes are measured in units; the prices are obtained by dividing baseline dollar volume by baseline units; sine and cosine are used to estimate the seasonal pattern; and a linear time trend was used in the study. The logarithm of unit volume and the unit prices are used in the regression and the model can be written as

$$\log(b_{it}) = \alpha_i + \beta_{i1}\log(p_{it}) + \beta_{i2}\sin(t) + \beta_{i3}\cos(t) + \beta_{i4}t + \beta_{i5}\,\%ACV_{it} + \varepsilon_{it}.$$

Where α and βs are parameters to be estimated, b_{it} denotes the baseline units of i^{th} product sold in week t; p_{it} is the average unit price of i^{th} product in week t; and ε_{it} is the disturbance term. Weekly data for \$2MM+ grocery stores for the period from 06/28/03 through 06/03/06 (154 observations) were used to estimate the above relationships. Results are presented in Tables 1-4.

As shown in these four tables, the estimated coefficients of all four types of promotional activity %ACVs are positive and statistically different from zero, an indication that retailers' promotional activities had positive impacts on baseline unit sales. Or, in other words, the baseline sales are not independent of promotional activities.

ACNielsen indicates that correlation does not equal causation and it is not unexpected to see a positive correlation between baseline volume and promotional activities. Baselines will often increase during promotions because more stores are being aggregated to arrive at the baseline than in non-promoted weeks (due to increases in distribution that often occur with promotions). The promoted volume is not used, but every store that has sales volume will contribute to the baseline.

ACNielsen also indicates that a seasonal effect for highly seasonal categories[1] (baking goods, hot cereal, cold remedies, etc.) could also impact baseline volumes. In the winter months, sales of OJ, for example, will increase without promotion. The baseline volume will increase during these months as more stores are contributing to the baseline. A promotion for cold remedies is not as effective in the summer as a promotion in the winter months.

[1] In this study, sine and cosine functions are used to estimate the seasonality in OJ sales; therefore, seasonality does not influence the findings of this study.

Table 1. Feature ad baseline unit sales and %ACV for feature ads

$\log(y_t)$	Intercept	$\text{Log}(p_t)$	%ACV for Feature Ads	Sine	Cosine	Time Trend
Apple Juice	12.2817*	-0.3719*	0.0118*	0.0474*	-0.2032*	-0.0016*
	(0.1494)	(0.1877)	(0.0022)	(0.0195)	(0.0201)	(0.0003)
Carb Water	11.7202*	-1.4712*	0.0586*	-0.0149	0.0742*	-0.0001
	(0.0811)	(0.1440)	(0.0047)	(0.0264)	(0.0252)	(0.0005)
Gft Juice	9.5494*	-0.5955*	0.1504*	-0.0268	-0.0810*	-0.0033*
	(0.2585)	(0.2299)	(0.0084)	(0.0420)	(0.0412)	(0.0011)
Grape Juice	10.7123*	-0.0198	0.0331*	-0.0938*	-0.0497*	-0.0025*
	(0.1889)	(0.1850)	(0.0022)	(0.0201)	(0.0201)	(0.0003)
Juice Drink	14.2930*	-0.7420*	0.0103*	0.0755*	0.1563*	0.0005*
	(0.1916)	(0.1834)	(0.0014)	(0.0142)	(0.0177)	(0.0002)
Milk	14.6931*	-0.2234	0.0343*	0.0092	0.0385*	0.0004
	(0.2680)	(0.2493)	(0.0037)	(0.0218)	(0.0211)	(0.0004)
OJ	15.1896*	-0.8692*	0.0055*	-0.0441*	-0.0571*	-0.0009*
	(0.2326)	(0.2048)	(0.0014)	(0.0096)	(0.0095)	(0.0002)
Rem Juice	12.8164*	-0.5575*	0.0163*	-0.0378	-0.0256	-0.0002
	(0.1594)	(0.1794)	(0.0027)	(0.0212)	(0.0208)	(0.0003)
Soft Drinks	15.7173*	-0.9835*	0.0108*	0.0303*	0.0168	0.0005*
	(0.2511)	(0.0858)	(0.0030)	(0.0107)	(0.0104)	(0.0002)
Liq Tea	12.3141*	-1.1730	0.0308*	0.1073*	0.0720*	0.0025*
	(0.1136)	(0.1062)	(0.0027)	(0.0227)	(0.0308)	(0.0005)
Veg Juice	10.4052*	-0.2784	0.0628*	-0.1179*	-0.1691*	0.0003
	(0.1815)	(0.1984)	(0.0034)	(0.0277)	(0.0274)	(0.0004)
Bottled Water	13.1818*	-0.9824*	0.0153*	0.1177*	0.1529*	0.0033*
	(0.1675)	(0.0873)	(0.0020)	(0.0137)	(0.0156)	(0.0003)

*Statistically different from zero at $\alpha = 0.05$ level.

Table 2. Display baseline unit sales and %ACV for displays

$\log(y_t)$	Intercept	$\text{Log}(p_t)$	%ACV for Displays	Sine	Cosine	Time Trend
Apple Juice	12.9224*	-1.0804*	0.0225*	0.0242*	-0.1262*	0.0005*
	(0.1005)	(0.1310)	(0.0020)	(0.0095)	(0.0101)	(0.0002)
Carb Water	12.1788*	-1.2514*	0.0350*	0.0142*	0.1510*	0.0017*
	(0.0423)	(0.1384)	(0.0020)	(0.0098)	(0.0103)	(0.0002)
Gft Juice	9.3816*	-0.3307	0.2754*	-0.1155*	0.0017	-0.0112*
	(0.1854)	(0.3069)	(0.0415)	(0.0355)	(0.0356)	(0.0011)
Grape Juice	9.2796*	1.1258*	0.0429*	-0.0348*	0.0283*	-0.0006*
	(0.2116)	(0.2160)	(0.0026)	(0.0139)	(0.0135)	(0.0002)
Juice Drink	14.3494*	-0.8689*	0.0097*	0.1246*	0.2091*	0.0013*
	(0.1416)	(0.1329)	(0.0013)	(0.0082)	(0.0196)	(0.0001)
Milk	11.5666*	0.1820	0.0342*	-0.0922*	-0.1476*	0.0023*
	(0.2484)	(0.2743)	(0.0049)	(0.0228)	(0.0229)	(0.0004)
OJ	11.7973*	-0.3476	0.0690*	-0.0752*	-0.0216	-0.0007*
	(0.1941)	(0.2383)	(0.0060)	(0.0124)	(0.0133)	(0.0003)
Rem Juice	12.5001*	-0.9125*	0.0228*	0.0219*	0.0335*	0.0021*
	(0.0333)	(0.0797)	(0.0023)	(0.0087)	(0.0085)	(0.0001)
Soft Drinks	16.3687*	-0.7177*	0.0072*	0.0064	0.0210*	0.0000
	(0.1791)	(0.0952)	(0.0021)	(0.0056)	(0.0063)	(0.0001)
Liq Tea	12.1582*	-1.1411*	0.0282*	0.1027*	0.1868*	0.0039*
	(0.1257)	(0.1238)	(0.0020)	(0.0127)	(0.0217)	(0.0002)
Veg Juice	11.1468*	-1.0680*	0.0654*	-0.0862*	-0.2113*	0.0005*
	(0.0415)	(0.0986)	(0.0034)	(0.0110)	(0.0157)	(0.0002)
Bottled Water	12.9216*	-0.5507*	0.0240*	0.1103*	0.1067*	0.0028*
	(0.1990)	(0.1919)	(0.0017)	(0.0091)	(0.0149)	(0.0004)

*Statistically different from zero at $\alpha = 0.05$ level.

Table 3. Feature ad and display baseline unit sales and %ACV for feature ads and displays

$\log(y_t)$	Intercept	$\text{Log}(p_t)$	%ACV for Feature Ads and Displays	Sine	Cosine	Time Trend
Apple Juice	12.0627*	-1.7341*	0.0611*	0.0259	-0.0279	-0.0009*
	(0.1135)	(0.1593)	(0.0035)	(0.0207)	(0.0206)	(0.0003)
Carb Water	10.3664*	-1.2944*	0.1764*	-0.0495	0.1565*	0.0007
	(0.0612)	(0.1114)	(0.0128)	(0.0322)	(0.0316)	(0.0006)
Gft Juice	7.5943*	-0.3471	1.1190*	-0.0403	0.0507	-0.0156*
	(0.2466)	(0.2313)	(0.1102)	(0.0887)	(0.0866)	(0.0017)
Grape Juice	8.6836*	0.4100*	0.1408*	-0.0374	0.0025	-0.0014*
	(0.2385)	(0.2253)	(0.0074)	(0.0335)	(0.0329)	(0.0005)
Juice Drink	12.8179*	-0.7437*	0.0232*	0.0663*	0.1219*	0.0017*
	(0.1239)	(0.1155)	(0.0019)	(0.0162)	(0.0321)	(0.0003)
Milk	11.8061*	-1.0877*	0.0713*	0.0050	-0.0626	0.0037*
	(0.2759)	(0.3379)	(0.0308)	(0.0583)	(0.0586)	(0.0010)
OJ	12.9117*	-1.0856*	0.0496*	-0.0381*	-0.0400*	0.0002
	(0.2420)	(0.2076)	(0.0052)	(0.0117)	(0.0116)	(0.0002)
Rem Juice	10.9155*	-0.8788*	0.1126*	-0.0063	0.0212	-0.0001
	(0.0743)	(0.1008)	(0.0105)	(0.0277)	(0.0261)	(0.0005)
Soft Drinks	14.9491*	-0.0735	0.0169*	0.0328*	0.0151	0.0002
	(0.2982)	(0.1399)	(0.0037)	(0.0152)	(0.0169)	(0.0002)
Liq Tea	10.8040*	-0.8021*	0.0833*	0.1008*	0.1681*	0.0021*
	(0.0881)	(0.0768)	(0.0066)	(0.0270)	(0.0428)	(0.0006)
Veg Juice	9.6610*	-0.9477*	0.2319*	-0.0778*	-0.2297*	-0.0008
	(0.1149)	(0.1558)	(0.0164)	(0.0385)	(0.0421)	(0.0007)
Bottled Water	11.7167*	-0.4511*	0.0368*	0.0976*	0.0801*	0.0033*
	(0.1738)	(0.1231)	(0.0021)	(0.0160)	(0.0267)	(0.0003)

*Statistically different from zero at $\alpha = 0.05$ level.

Table 4. TPR baseline unit sales and %ACV for TPR

$\log(y_t)$	Intercept	$\text{Log}(p_t)$	%ACV for TPR	Sine	Cosine	Time Trend
Apple Juice	12.7656*	-0.0845	0.0091*	-0.0256*	-0.1210	-0.0005*
	(0.2374)	(0.2530)	(0.0024)	(0.0119)	(0.0126)	(0.0002)
Carb Water	12.7958*	-2.0357*	0.0234*	0.0080	0.0735*	0.0018*
	(0.1480)	(0.2049)	(0.0033)	(0.0164)	(0.0160)	(0.0005)
Gft Juice	11.6011*	-0.6822*	0.0364*	-0.0443*	0.0107	-0.0039*
	(0.1655)	(0.1649)	(0.0017)	(0.0139)	(0.0134)	(0.0004)
Grape Juice	10.4159*	1.0389*	0.0168*	-0.0519*	0.0066	-0.0014*
	(0.2411)	(0.2498)	(0.0022)	(0.0129)	(0.0126)	(0.0002)
Juice Drink	14.2628*	-0.2706	0.0158*	0.0439*	0.1517*	0.0011*
	(0.3772)	(0.2109)	(0.0038)	(0.0088)	(0.0105)	(0.0001)
Milk	11.9719*	0.2605	0.0596*	-0.0973*	-0.1162*	0.0006
	(0.2882)	(0.3320)	(0.0022)	(0.0249)	(0.0241)	(0.0004)
OJ	14.4038*	-0.3809	0.0105*	-0.0652*	-0.0621*	-0.0010*
	(0.3309)	(0.2785)	(0.0036)	(0.0104)	(0.0100)	(0.0002)
Rem Juice	14.4688*	-1.1310*	0.0066*	-0.0454*	-0.0301*	0.0003
	(0.2045)	(0.1600)	(0.0025)	(0.0108)	(0.0111)	(0.0002)
Soft Drinks	15.7448*	-0.7120*	0.0110*	-0.0069	0.0335*	-0.0004*
	(0.4995)	(0.1318)	(0.0055)	(0.0088)	(0.0083)	(0.0002)
Liq Tea	13.7601*	-0.5719*	0.0044*	0.1077*	0.1797*	0.0022*
	(0.2974)	(0.1498)	(0.0035)	(0.0104)	(0.0131)	(0.0003)
Veg Juice	10.3547*	1.1111*	0.0255*	-0.0493*	-0.1262*	-0.0009*
	(0.2772)	(0.2590)	(0.0036)	(0.0168)	(0.0164)	(0.0003)
Bottled Water	12.9156*	-0.7015*	0.0256*	0.0457*	0.1404*	0.0019*
	(0.3033)	(0.1650)	(0.0036)	(0.0093)	(0.0120)	(0.0003)

*Statistically different from zero at $\alpha = 0.05$ level.