Abstract

GreenMarketplace.com (GMP) is the premier Internet retailer of socially and environmentally friendly products. In order to increase its sales and revenue, GMP has instituted a bi-weekly promotional sale, advertised through e-mail flyers. Although the company has informally investigated how changing elements of the promotions affects sales and revenue, it has not discovered a formula for the best promotion for its current and changing needs. This report explores elements of GMP's promotions in an attempt to find an optimal recipe. While informal data analysis does indicate weak associations between various elements of a promotion and the level of daily sales and revenue, the best model based on these elements can not reliably predict sales and revenue for a promotion two weeks in the future. Further work and more data could unveil models that better account for the overall increasing trend in sales and revenue, and would be accurate predictors.

I. Introduction

GreenMarketplace.com (GMP) is the premier Internet retailer of socially and environmentally friendly products. As part of the company's sales strategy, it implemented a free membership program that allows those who share demographic and contact information with GMP to receive a discount on all orders. In September of 2000, GreenMarketplace.com (GMP) began to experiment with promotional sales, advertised with e-mail fliers sent to all members. Since that time, GMP has varied some of the many factors that could influence the success of the promotion in terms of increased and sustained revenues and sales.

The company has informally analyzed the effects of these variations, but has not successfully created a "formula" to predict sales and revenues for a particular combination of promotion components. This report presents analysis intended to discover a recipe to maximize the number of sales and revenue during promotions; it includes informal and formal conclusions about the most relevant factors in determining a successful promotion so that GMP can consistently increase sales and revenues.

The specific factors addressed are:

- number of products put on sale
- type of products promoted
- cost of products promoted
- size of the discounts
- length of the promotional sales
- day of the week on which the promotion begins
- days of the week that the promotion covers
- number of flyers e-mailed.

The following section (Data) contains information about the data used to analyze the importance of these factors. The Analysis and Discussion section contains the formal analysis and model building. Conclusions are found in the last report section, followed by technical appendices that include extensive plots, model selection detail, and a glossary.

II. Data

The data consist of two distinct parts[1]:

1. The historical total of number of daily sales and daily revenue and historical number of daily sales and daily revenues for 26 of the promoted products between March 8, 1999 and October 20, 2001. GMP computers automatically collect sales and revenue information, which was then compiled by GMP staff.

2. Promotion information, including which products were discounted, product category, original sale price, percent discount, starting day of the promotion, length of the promotion and the number of flyers e-mailed. GMP staff record promotion information at the time of each promotion.

Focus will be placed on finding predictors for:

1. total company sales by day
2. total company revenue by day
3. individual promotion items sales by day
4. individual promotion items revenue by day

Possible predictors (determinants) available for study include:

1. category of products included in the sale
2. number of flyers e-mailed
3. length of the promotion
4. number of products promoted
5. price (or price categories) of products promoted
6. percent discount (for total information, average percent discount and highest percent discount)
7. the month of the promotion
8. the day on which the promotion began
9. days of the week included in the promotion

Figure **??** shows GMP's overall sales and revenues, with the start days for the promotions marked. Similar plots for each of the individual products, grouped by product type, are shown in Figures **??** through **??**. These plots evidence a distinct change in GMP's business near the end of the first quarter of 2000. Because this analysis is focused on the time during which promotions took place, the data used for the formal analysis will only include days after September 1, 2000. September first was chosen because it is far enough away from the point of the fundamental company change to ensure the company has stabilized in its new pattern, yet is several weeks before the first promotion and so provides an adequate baseline.

Before exploring which elements of a promotion are best, the overall sales/revenue advantage of promotions must be established. Figure **??** shows histograms and boxplots that clearly indicate that sales and revenue increases during promotion days.

[1] descriptions of the data codes are found in Appendix A, the Glossary

The behavior of each of the individual determinants for the overall sales and revenue models, as well as its correlation with sales and revenue, are portrayed in plots in Appendix B. Most notable among these is the lack of any strong trends. Weak correlations include:

- The first two days of a promotion are best in sales and revenue. The third day could also be better for revenue.
- More products in a promotion generate more sales and revenue.
- Sales may increase with an increase in the average percent discount offered.
- Including Tuesday in a promotion may generate more sales.
- A promotion that lasts two or three days generates more sales and revenue than those that last longer.

Similar plots for pooled product sales and revenues are in Appendix C. Again, there were no outstanding relationships. The strongest are:

- Home category products performed better in revenue and sales.
- The first and second days of a promotion generated the most revenue and sales.
- An increase in the number of flyers e-mailed increases the number of sales and revenue generated by a promotion.
- Including Wednesday in a promotion increases sales.

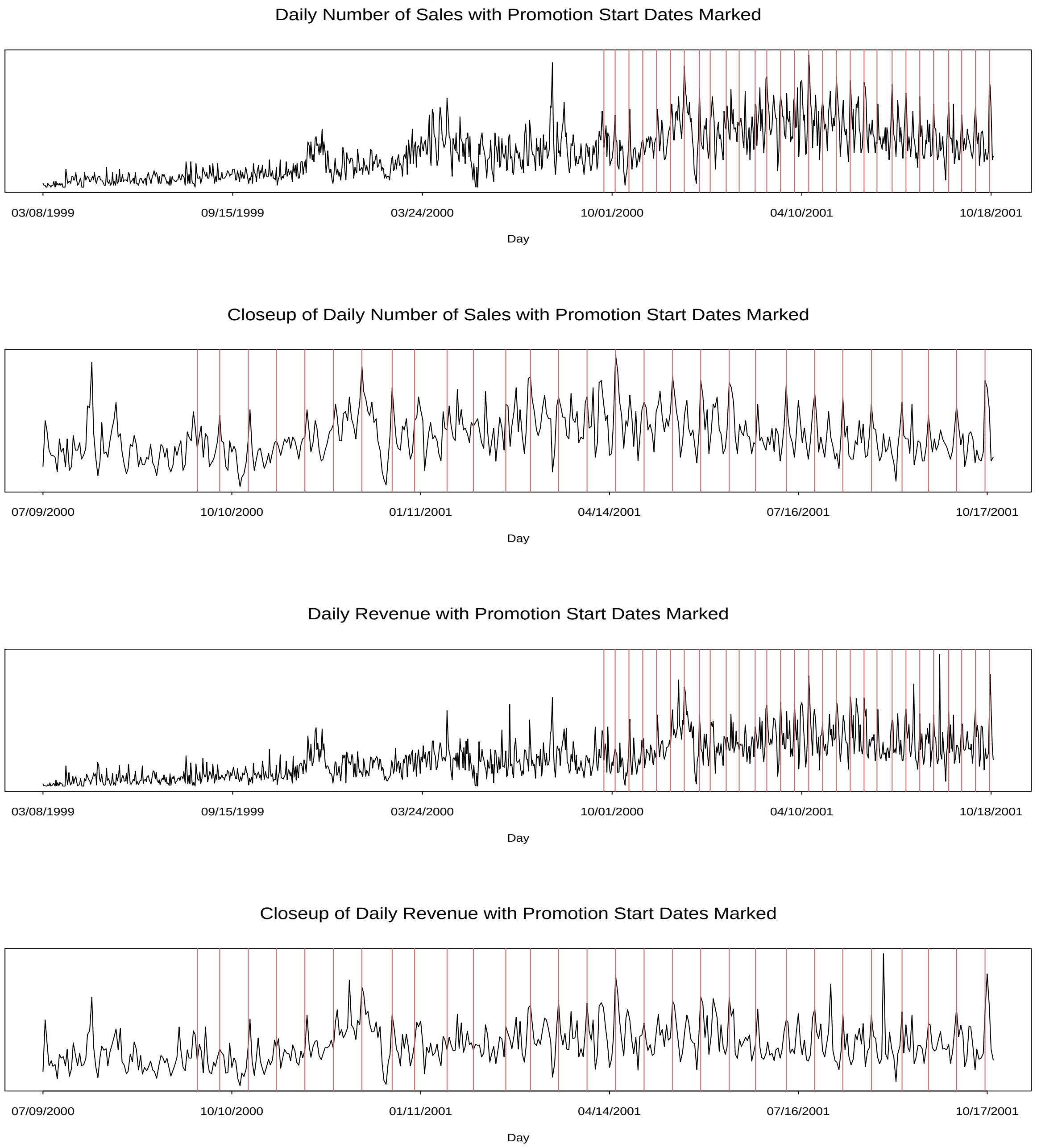

Figure 1: Overall Sales and Revenue, with Promotion Start Days Marked

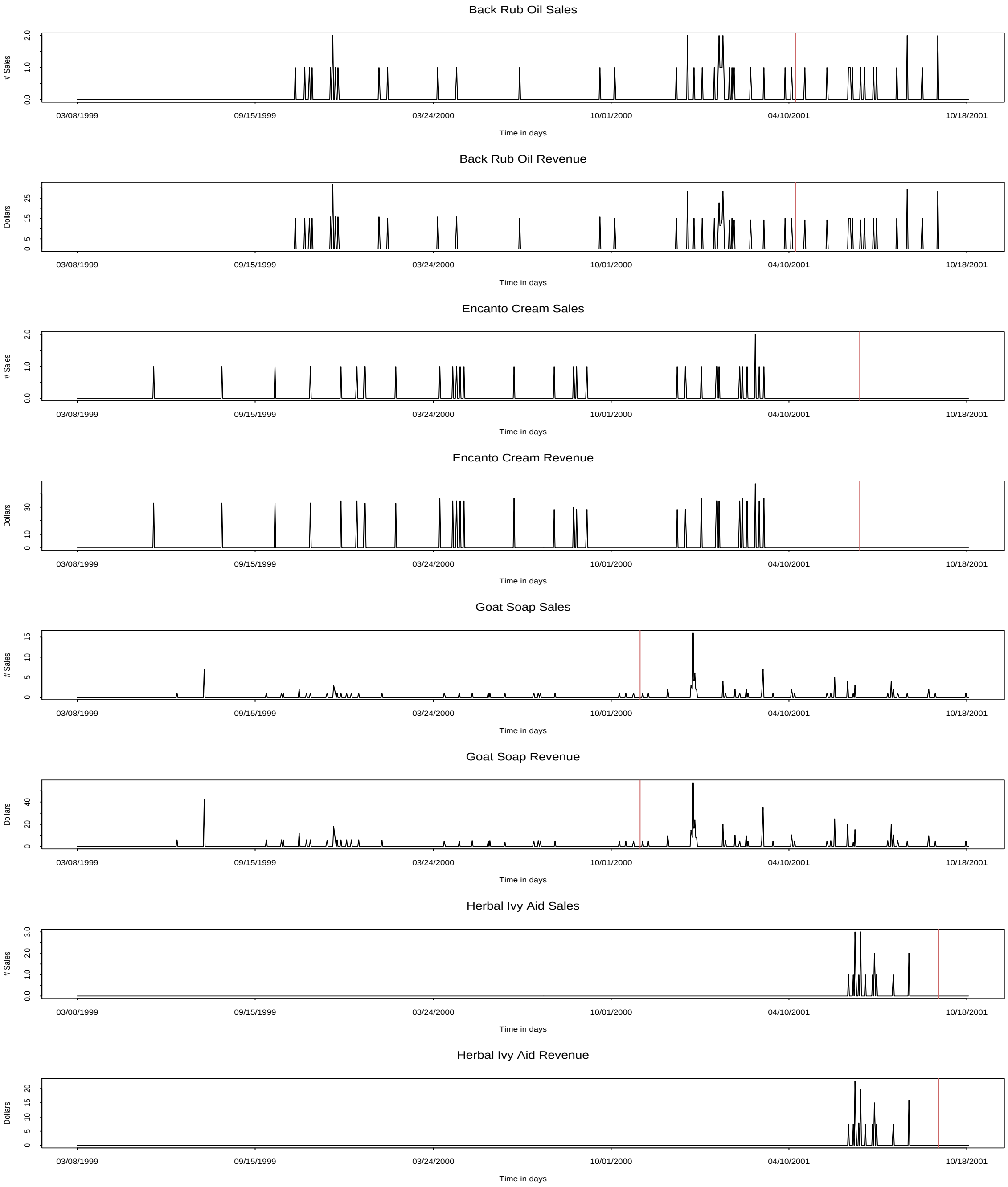

Figure 2: Body Product Sales and Revenue, with Promotion Start Days Marked (Part 1)

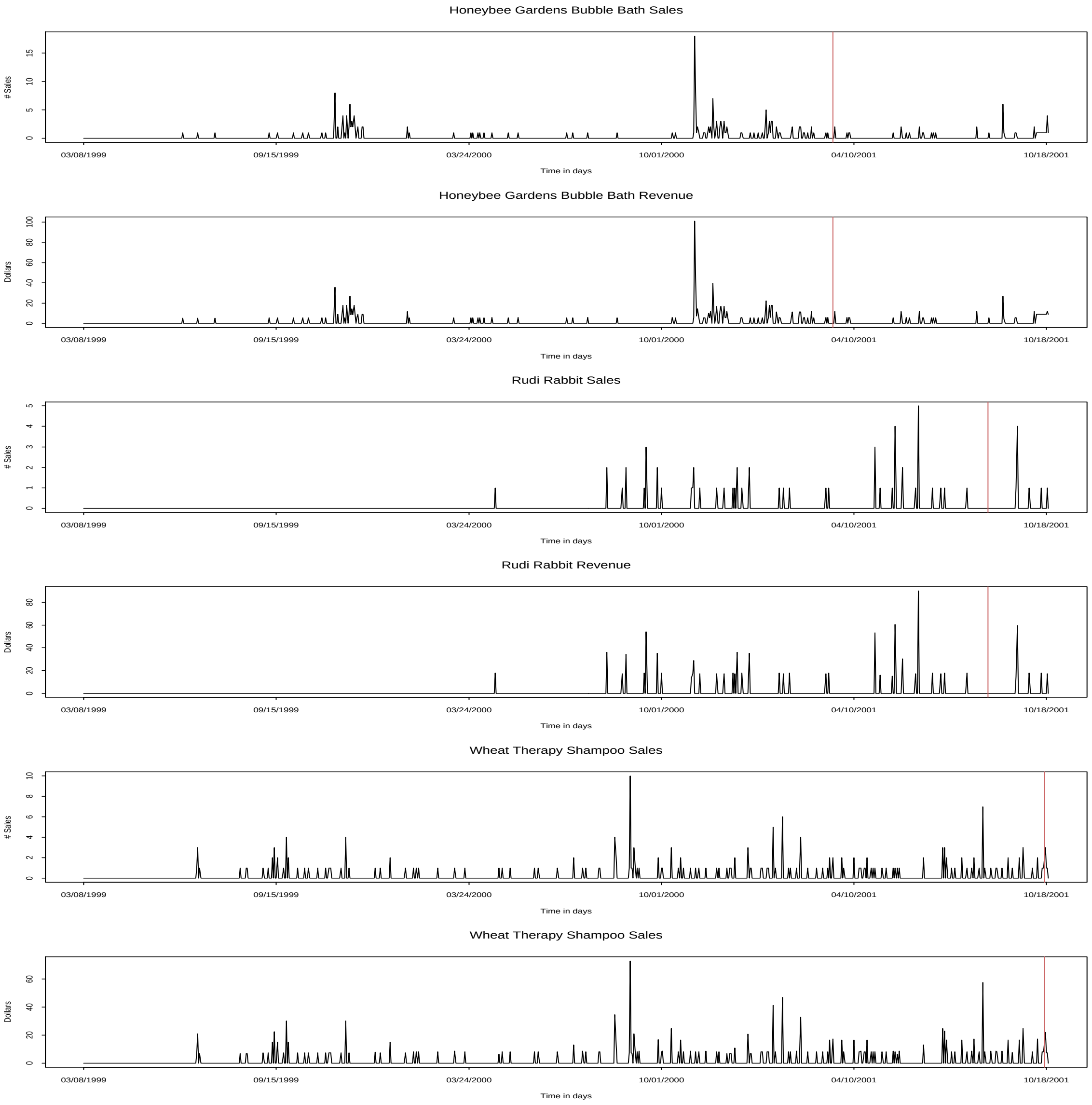

Figure 3: Body Product Sales and Revenue, with Promotion Start Days Marked (Part 2)

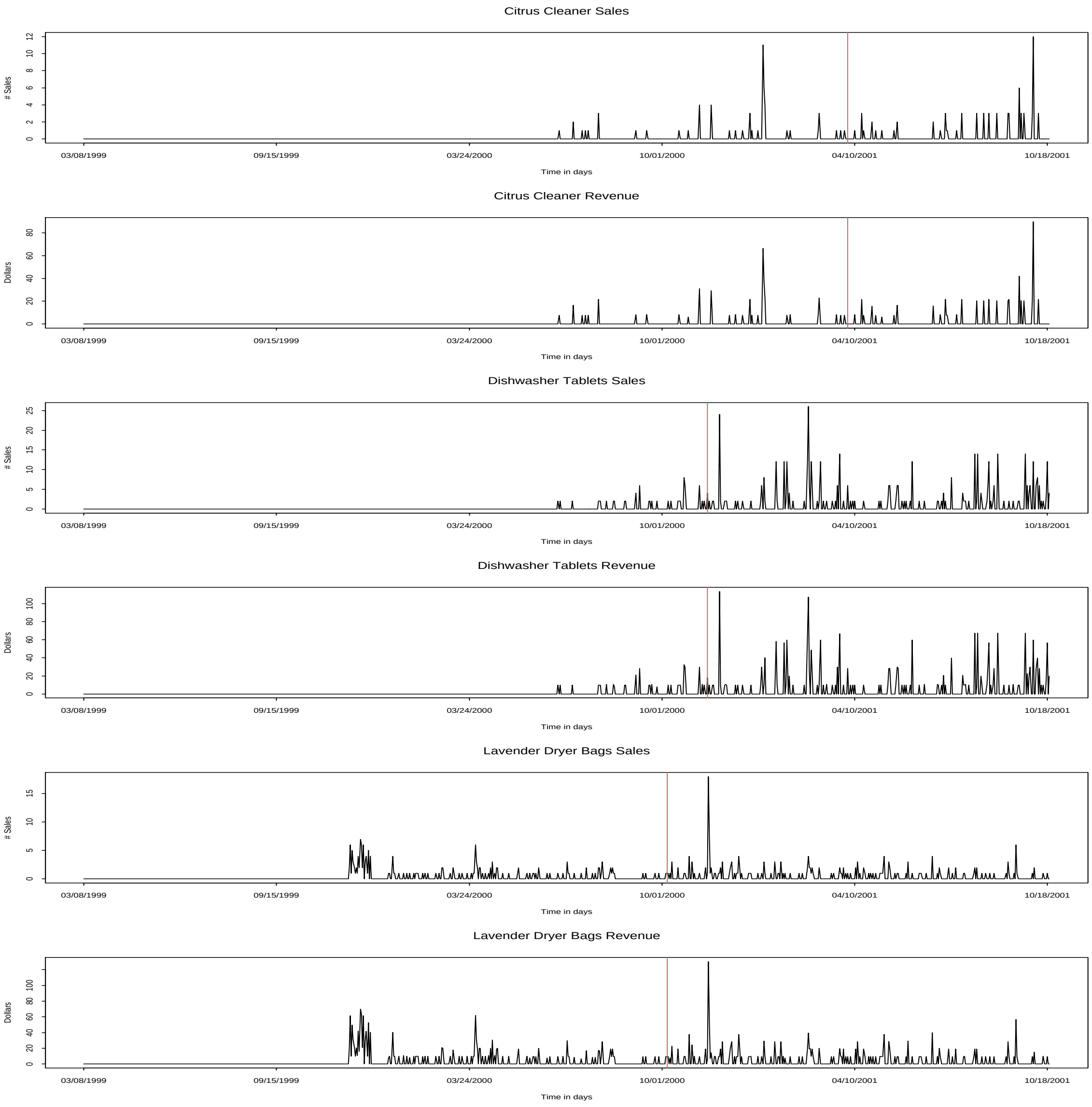

Figure 4: Cleaning Product Sales and Revenue, with Promotion Start Days Marked

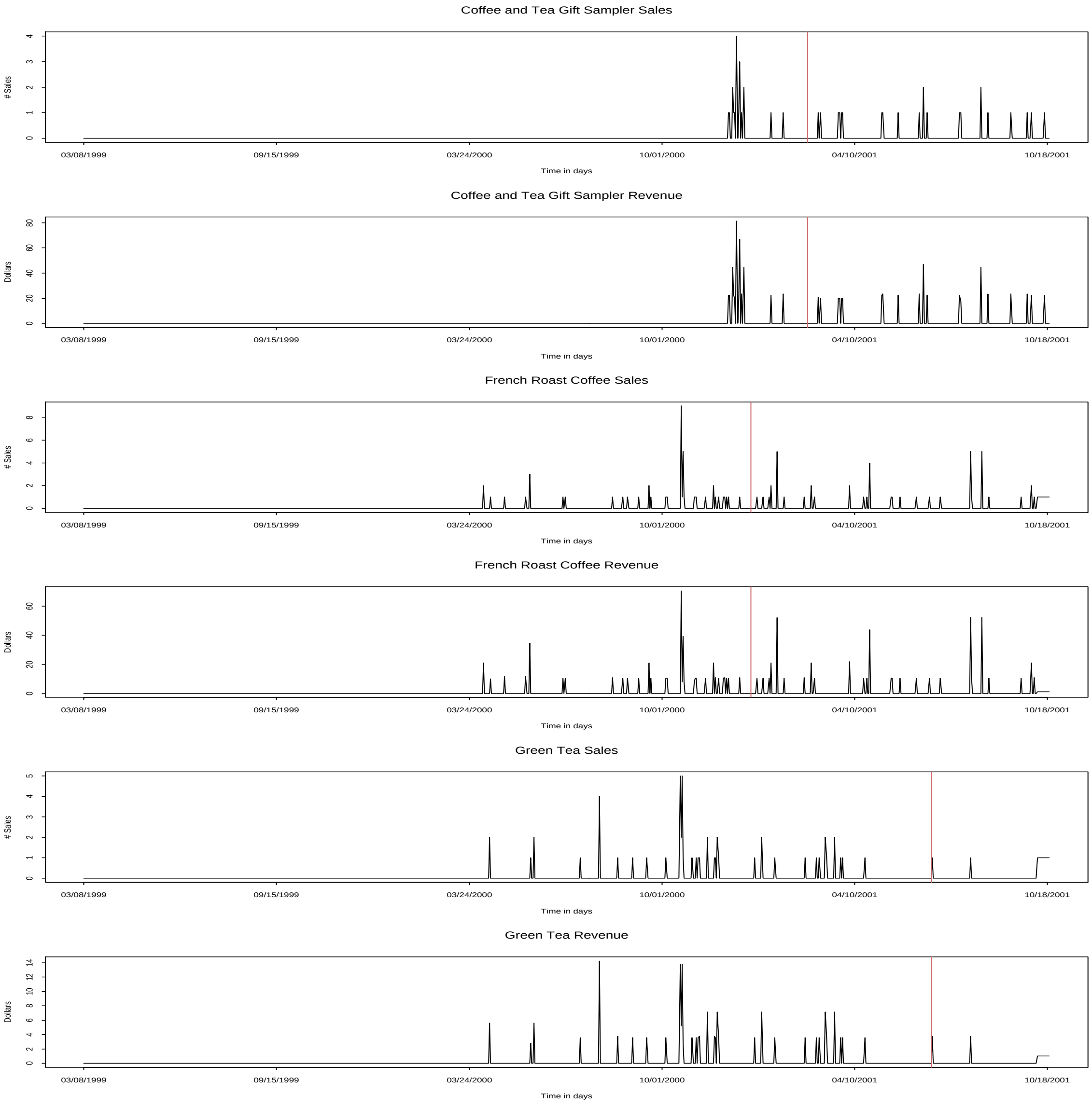

Figure 5: Food Product Sales and Revenue, with Promotion Start Days Marked (Part 1)

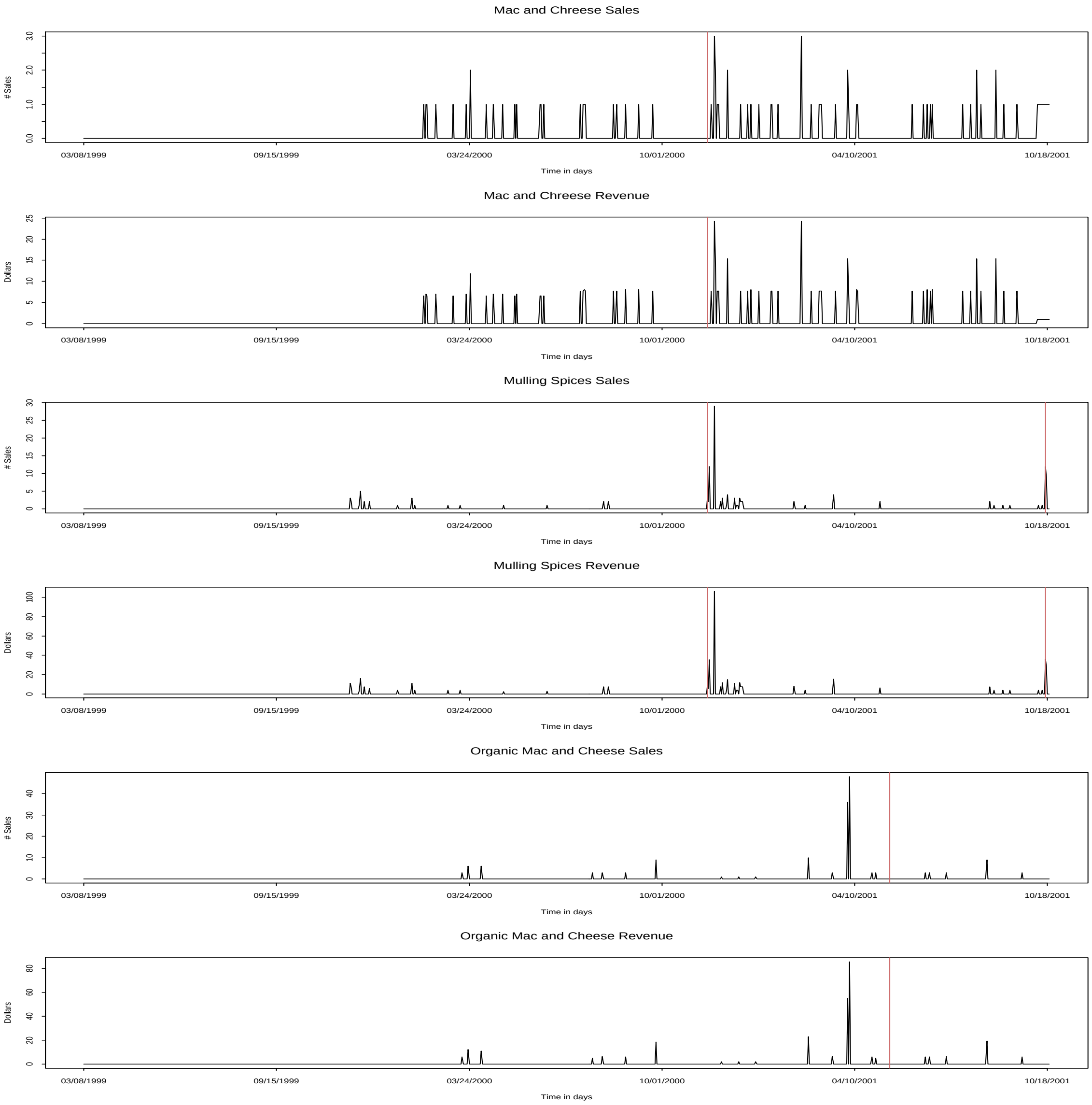

Figure 6: Food Product Sales and Revenue, with Promotion Start Days Marked (Part 2)

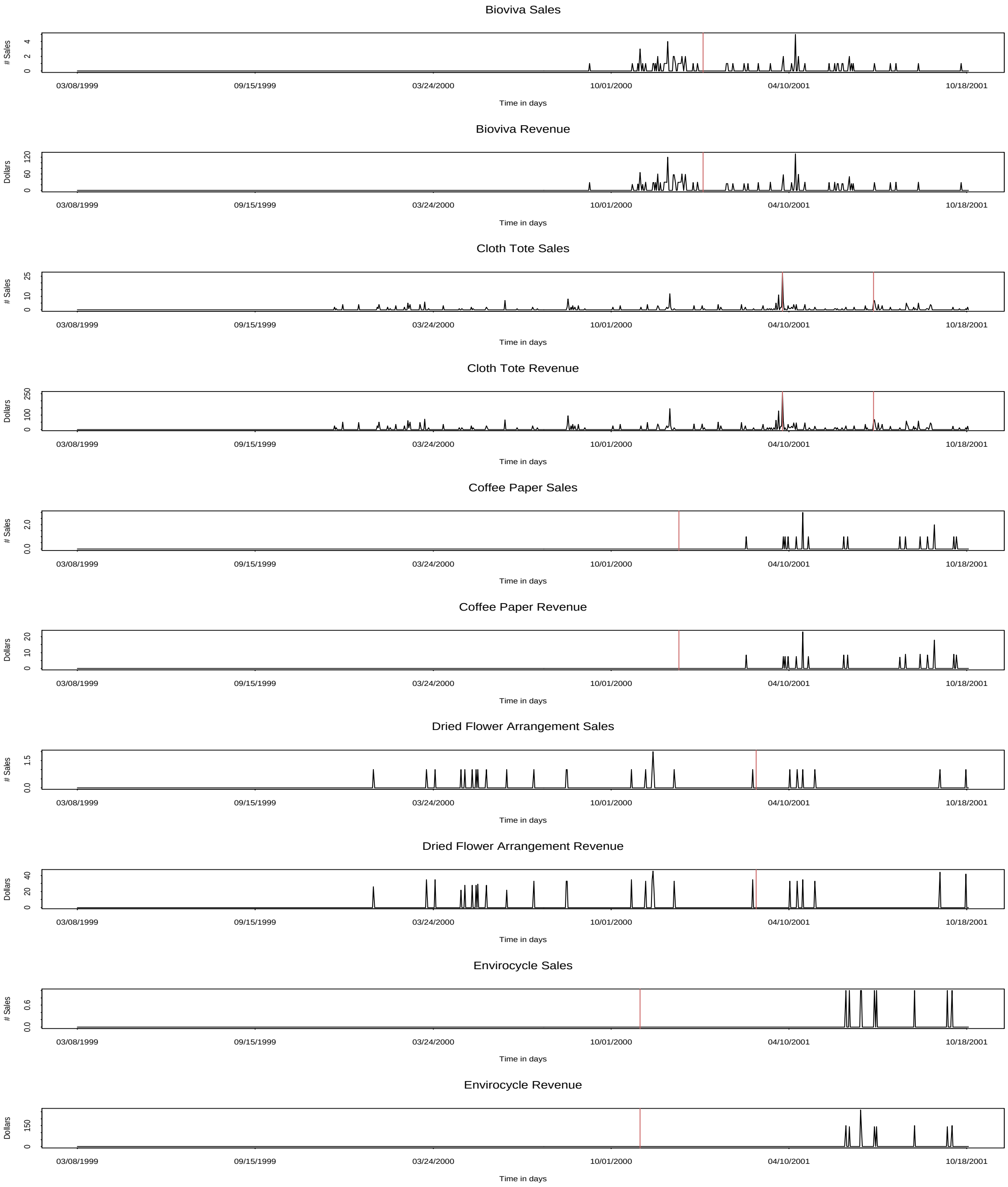

Figure 7: Home Product Sales and Revenue, with Promotion Start Days Marked (Part 1)

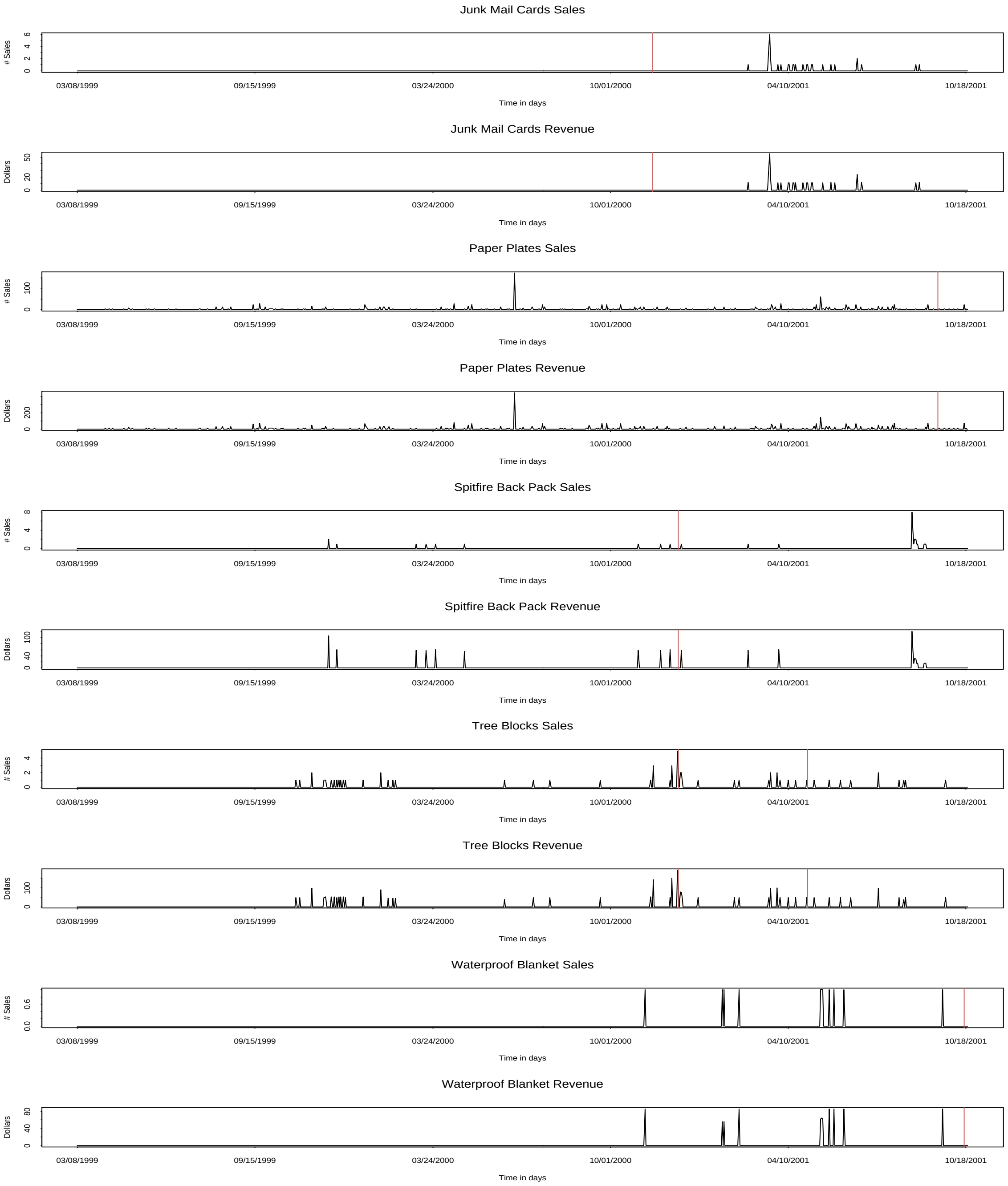

Figure 8: Home Product Sales and Revenue, with Promotion Start Days Marked (Part 2)

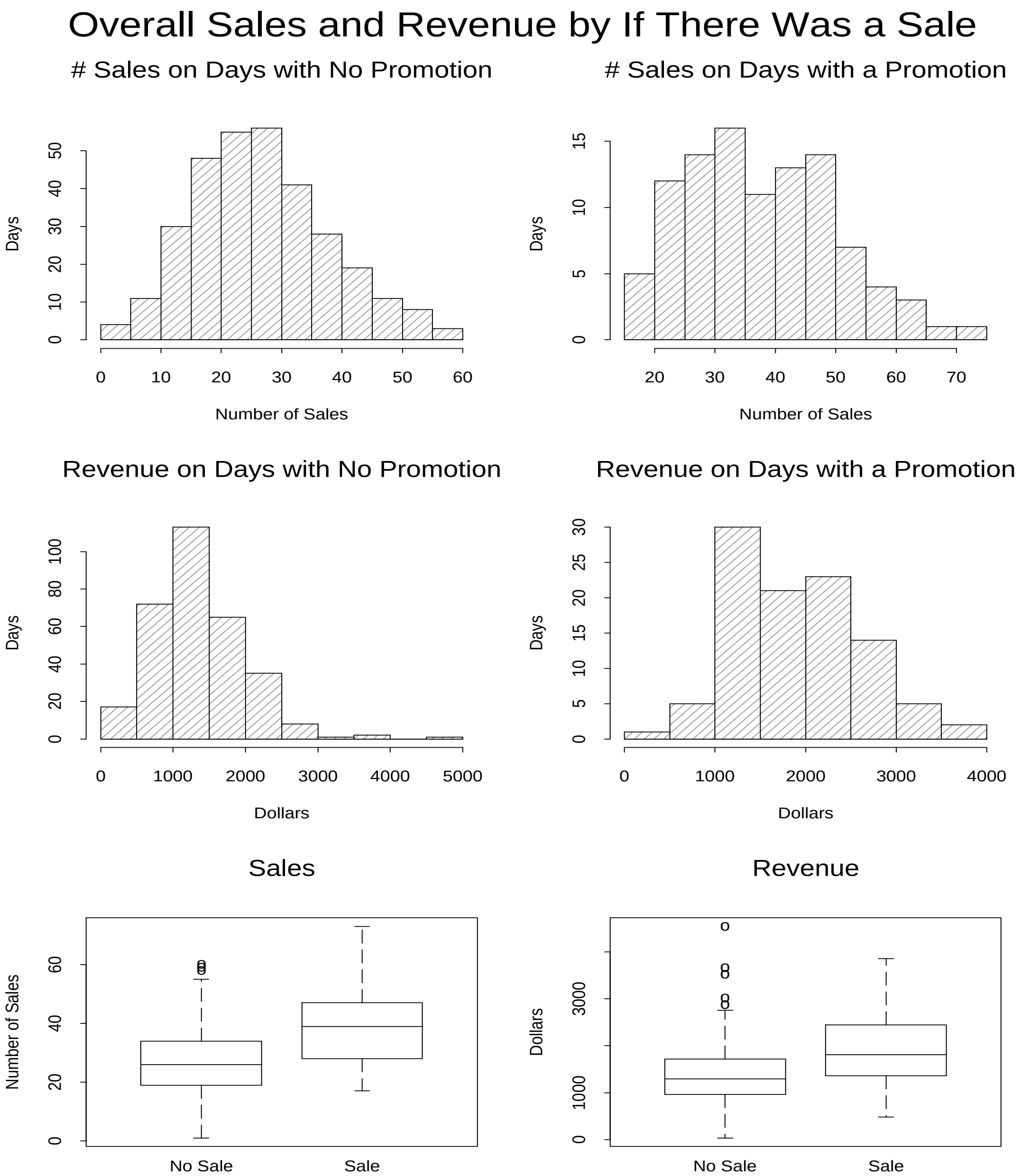

Figure 9: Overall Sales and Revenue by Whether or Not there Was a Sale

Correlation between the determinants and Sales and Revenue are used as a proxy for the strength of a relationship. If the correlation is one, the relationship is very strong and positive (i.e., the higher the determinant value, the higher the sales/revenue); if the correlation is negative one, the relationship is very strong and negative (i.e., the higher the determinant value, the lower the sales/revenue); if the correlation is close to zero, there is no relationship (i.e., an increase or decrease in the determinant value has no effect on sales/revenue). For the overall company sales and revenue, the correlations are[2]:

	sales	revenue
flyers	0.422	0.390
numprods	0.402	0.369
body	0.222	0.213
home	0.416	0.412
cleaning	0.125	0.055
food	0.221	0.228
clothes	0.117	0.149
aveperc	0.379	0.310
highperc	0.399	0.336
price1	0.242	0.230
price2	0.218	0.202
price3	0.323	0.298
price4	0.192	0.130
price5	0.210	0.180
is.sale	0.387	0.343
start.sat	-0.032	-0.046
start.mon	0.084	0.082
start.tue	0.396	0.369
start.wed	0.084	0.076
start.thu	0.067	0.024
sat.sun	0.023	0.006
mon	0.096	0.072
tue	0.381	0.351
wed	0.377	0.347
thu	0.404	0.357
fri	0.108	0.080
length	0.315	0.275
jan	0.037	-0.033
feb	0.059	-0.017
mar	0.174	0.094
apr	0.196	0.150
may	0.171	0.124
jun	0.058	0.080
jul	0.005	0.007
aug	-0.106	0.008
sep	-0.244	-0.203
oct	-0.229	-0.172
nov	-0.079	-0.093
dec	0.102	0.167
d.mon	0.126	0.110
d.tue	0.280	0.217
d.wed	0.164	0.137
d.thu	0.095	0.098
d.fri	-0.039	-0.043
d.sat	-0.349	-0.294
d.sun	-0.274	-0.223
dos.1	0.351	0.289
dos.2	0.250	0.240
dos.3	0.069	0.068
dos.4	-0.039	-0.045
dos.5	-0.014	0.002
dos.6	0.044	0.012

[2]explanations of the codes are in Appendix A, the Glossary.

It is obvious here that there are no very strong relationships between the determinants and overall sales and revenue, since the largest correlation was about 0.4. For the formal analysis, I will focus on the variables that had a correlation of greater than 0.1:

1. For Sales:
    - Number of Flyers
    - Number of Products in the Promotion
    - Category of Product Represented in the Promotion (all categories)
    - Promotion Discount (Average and Highest Percents)
    - Price Category Represented in the Promotion (all categories)
    - If There is a Promotion Occurring
    - If the Promotion Starts on Tuesday
    - If the Promotion includes Tuesday, Wednesday, Thursday or Friday
    - The length of the Promotion
    - The Month (specifically, March, April, May, August, September, October and December, but all will be included for technical reasons[3])
    - The Day of the Week (specifically, Monday, Tuesday, Wednesday, Saturday and Sunday, but all will be included for technical reasons[4])
    - The Day of the Promotion (first or second day)
2. For Revenue:
    - Number of Flyers
    - Number of Products in the Promotion
    - Category of Product Represented in the Promotion (all categories except Cleaning)
    - Promotion Discount (Average and Highest Percents)
    - Price Category Represented in the Promotion (all categories)
    - If There is a Promotion Occurring
    - If the Promotion Starts on Tuesday
    - If the Promotion includes Tuesday, Wednesday, or Thursday
    - The length of the Promotion
    - The Month (specifically, April, May, September, October and December, but all will be included for technical reasons[5])
    - The Day of the Week (specifically, Monday, Tuesday, Wednesday, Saturday and Sunday, but all will be included for technical reasons[6])
    - The Day of the Promotion (first or second day)

Similarly, the product sales and revenue correlation with their possible predictors is:

[3] By including the months, seasonal autocorrelation is minimized, and model interpretation is improved.
[4] By including the days, weekly autocorrelation is minimized, and model interpretation is improved.
[5] By including the months, seasonal autocorrelation is minimized, and model interpretation is improved.
[6] By including the days, weekly autocorrelation is minimized, and model interpretation is improved.

	sales	revenue
price	-0.067632627	0.017605877
dos1	0.208449638	0.195174179
dos2	0.112499726	0.181236002
dos3	0.100640748	0.091978409
dos4	0.013562981	0.010533146
dos5	0.027917322	0.016218032
discount	0.182564101	0.221380804
dmon	0.003276687	-0.004641586
dtue	0.035562141	0.043454662
dwed	0.005993779	0.021523538
dthu	0.015423689	0.014674644
dfri	0.006784569	-0.002045986
dsat	-0.034481214	-0.038739166
feb	-0.006479398	-0.008302152
mar	0.005014489	0.002086366
apr	0.013874669	0.013154940
may	0.006712928	-0.001050926
jun	-0.002936974	0.013655904
jul	-0.005813063	-0.005875425
aug	-0.006479398	-0.008302152
sep	0.005014489	0.002086366
oct	0.013874669	0.013154940
nov	0.006712928	-0.001050926
dec	-0.002936974	0.013655904
flyers	0.246865002	0.272295061
length	0.225393471	0.231743510
sat.sun	0.121230068	0.091807149
mon	0.133908903	0.164761779
tue	0.211519546	0.236517951
wed	0.132136715	0.080991995
thu	0.004477537	0.115588260
fri	0.205718068	0.233324517

Although this report does not formally explore these relationships, the strongest possible determinants are:

1. For Sales:
   - The Day of a Promotion (the first three days)
   - The Discount Offered
   - The Number of Flyers
   - The Length of the Promotion
   - The Days of the Week Included in the Promotion (all except Thursday)
2. For Revenue:
   - The Day of a Promotion (the first two days)
   - The Discount Offered
   - The Number of Flyers
   - The Length of the Promotion
   - The Days of the Week Included in the Promotion (Monday, Tuesday, Thursday and Friday)

III. Analysis and Discussion

Further investigation of whether or not a promotion increases sales and revenue can easily be done with a general least squares regression, which tests if the average number of sales/dollars of revenue during a promotion are greater than the corresponding value when there is no promotion[7].

The results of the regression show that for:

1. sales: nine more sales occur during a promotion than when there is no promotion, with almost 100% confidence.
2. revenue: $496 more are spent during a promotion than when there is no promotion, with almost 100% confidence.

Unfortunately, these results are not entirely dependable because of the reliance of one day's sales/revenue on previous days' sales/revenue (i.e., autocorrelation) is not entirely taken into account. However, because these results are so strong, there is evidence that a predictive model based promotion characteristics may be possible.

Fitting a larger model alleviates autocorrelation through the inclusion of month and day of week data. For the linear model to be reliable, the sales and revenue variables must be distributed in a bell-shaped curve (a normal distribution); the square root of both sales and revenue meets this requirement (see Figure **??**

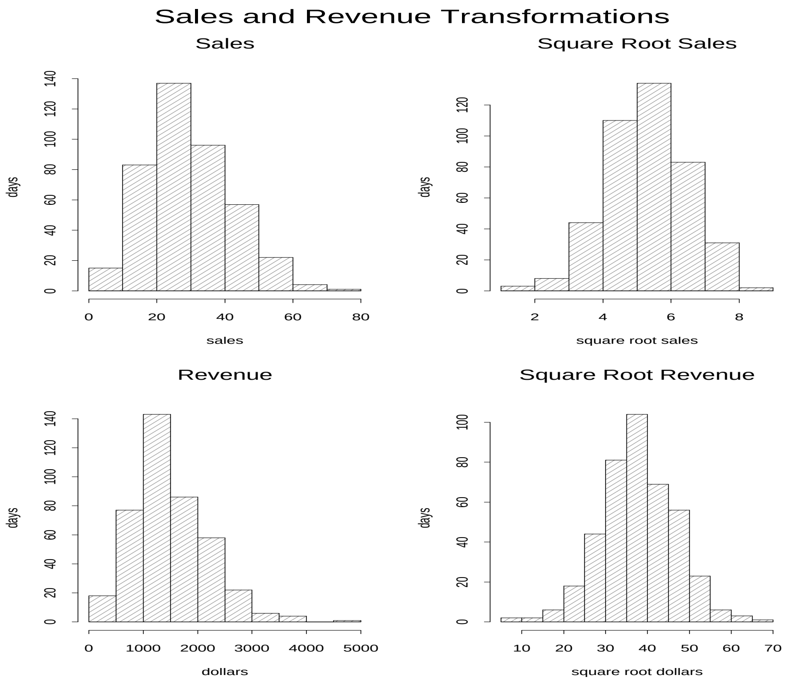

Figure 10: Overall Sales and Revenue Transformations

[7]The diagnostic plots (Figures **??** and **??**) and summaries for these regressions can be found in Appendix D

Beginning with the variables enumerated at the end of the Data section (those with correlation greater than 0.1), a standard method of model selection found the best linear model to predict sales/revenue during future promotions.[8]

The best models included the variables:

- Sales - aveperc, highperc, price5, jan, feb, mar, apr, may, jun, jul, aug, sep, oct, nov, d.mon, d.tue, d.wed, d.thu, d.fri, dos.1, dos.2, xmas, thu.

  (Although the model selection only chose some of the months as significant, I include them all here, since they are needed to eliminate autocorrelation and interpretation would be difficult if I did not.)

- Revenue - numprods, body, home, food, clothes, aveperc, highperc, price1, price2, price3, price4, price5, is.sale, start.tue, tue, wed, thu, length, feb, mar, apr, may, jun, jul, aug, sep, oct, nov, dec, d.mon, d.tue, d.wed, d.thu, d.fri, d.sat dos.1, and dos.2.

  (Although the model selection only chose some of the months and days of the week as significant, I include them all here, since they are needed to eliminate autocorrelation and interpretation would be difficult if I did not.)

The specific linear models are[9]:

- **Sales**

$$\begin{aligned}
\sqrt{sales} &= 4.66 - 0.411(average\%) + 1.33(highest\%) - 0.63(includesaproductover\$50) \\
&+0.10(inFeb) + 0.62(inMar) + 0.60(inApr) + 0.52(inMay) \\
&+0.23(inJun) - 0.12(inJul) - 0.61(inAug) - 0.76(inSep) \\
&-0.94(inOct) - 0.52(inNov) + 0.22(inDec) \\
&+1.15(Monday) + 1.28(Tuesday) + 0.93(Wednesday) + 0.71(Friday) \\
&-0.23(Saturday) + 0.83(FirstDayofSale) + 0.69(SecondDayofSale)
\end{aligned}$$

  Thus, sales increase with a high percent discount and on the first two days of the sale; sales decrease with a high average percent discount (as a penalty for already including the highest percent discount in the model) and inclusion of products priced over $50; and sales are not affected by the other promotion characteristics. The remaining variables included in the model account for seasonal and weekly sales cycles.

- **Revenue**

$$\begin{aligned}
\sqrt{revenue} &= 32.35 - 0.60(\#products) - 2.66(bodyproduct) + 5.11(homeproduct) \\
&+0.05(foodproduct) - 0.84(clothesproduct) - 13.46(average\%) \\
&-6.94(highest\%) - 1.71(under\$10included) - 3.26(\$10to\$20included) \\
&+1.05(\$20to\$30included) - 6.27(\$30to\%50included) - 6.55(over\$50included) \\
&+10.98(ifthereisapromotion) + 4.25(startsonTuesday) \\
&-2.71(Tuesdayincluded) + 1.38(Wednesdayincluded) + 0.59(Thursdayincluded) \\
&-0.31(lengthofpromotion) + 0.23(inFeb) + 4.46(inMar) \\
&+3.45(inApr) + 4.19(inMay) + 3.85(inJun) \\
&+0.38(inJul) + 0.65(inAug) - 3.48(inSep)
\end{aligned}$$

[8]The model selection process is fully described in Appendix E.
[9]Complete model summaries and diagnostic plots (Figures ?? and ??) are in Appendix D

$$-4.96(inOct) - 2.65(inNov) + 5.04(inDec)$$
$$+7.20(Monday) + 7.12(Tuesday) + 4.74(Wednesday)$$
$$+5.15(Thursday) + 3.92(Friday) - 1.83(Saturday)$$
$$+4.97(FirstDayofPromotion) + 5.03(SecondDayofPromotion)$$

Thus, revenue increases with the inclusion of home products and food products and products between \$20 and \$30, by having Wednesday and Thursday part of the promotion, and on the first two days of the promotion; revenue decreases with more products included in the sale, by including body and clothes products, by including products less than \$20 or greater than \$30, and by including Tuesday in the sale; and revenue is not affected by any of the other promotion variables considered. The months and days included in the model account for seasonal and weekly revenue variations.

If valid, the above models would be very useful in determining the types of promotions to hold in the future. To examine their validity, the models were tested against the last four promotions in the data. For the models to be useful, they must be able to predict sales/revenue at least two weeks in advance (so that products can be stocked and the flyer can be prepared); thus, the models were recalculated using only data up to two weeks before the promotion in question. The recalculated models were used to predict the sales/revenue during each day of the four sales and calculate an interval of error (a 95% Confidence Interval). These are reported along with the true values in the tables below.

SALES PREDICTIONS						
Date	Prediction	Lowest Error	Highest Error	True Value	Correct Prediction	Difference
9/5/01	5.664074	4.232036	7.096113	6.855655	T	-1.19158037
9/6/01	5.625319	4.193280	7.057357	5.385165	T	0.24015372
9/7/01	4.786004	3.353965	6.218042	5.196152	T	-0.41014890
9/18/01	6.055709	4.633672	7.477745	6.324555	T	-0.26884681
9/19/01	5.618100	4.196063	7.040136	5.567764	T	0.05033519
9/20/01	4.990823	3.568786	6.412859	4.472136	T	0.51868676
10/2/01	5.699420	4.266663	7.132177	6.708204	T	-1.00878378
10/3/01	5.231639	3.798882	6.664396	5.830952	T	-0.59931328
10/4/01	4.608620	3.175863	6.041377	4.898979	T	-0.29035970
10/16/01	5.791928	4.360649	7.223207	7.681146	F	-1.88921744
10/17/01	5.297564	3.866285	6.728843	7.416198	F	-2.11863477
10/18/01	4.644360	3.213081	6.075639	6.557439	F	-1.91307843
average difference: -0.7400657						
t-statistic for testing if this is different than zero: -0.9470364						
p-value: 0.3639605						

REVENUE PREDICTIONS						
Date	Prediction	Lowest Error	Highest Error	True Value	Correct Prediction	Difference
9/5/01	38.79481	25.91398	51.67563	50.62934	T	-11.834531
9/6/01	40.19173	27.31091	53.07256	33.93184	T	6.259889
9/7/01	32.62985	19.74902	45.51067	46.04563	F	-13.415781
9/18/01	33.16555	20.06569	46.26540	46.41077	F	-13.245228
9/19/01	30.83001	17.73015	43.92986	46.07114	F	-15.241135
9/20/01	26.34864	13.24879	39.44850	36.48767	T	-10.139025
10/2/01	36.57404	23.27285	49.87522	51.69042	F	-15.116388
10/3/01	33.55965	20.25846	46.86083	41.25458	T	-7.694930
10/4/01	29.36353	16.06234	42.66471	45.89989	F	-16.536362
10/16/01	39.39807	25.98965	52.80649	50.57994	T	-11.181863
10/17/01	36.60860	23.20018	50.01702	62.04982	F	-25.441218
10/18/01	32.07028	18.66186	45.47869	52.28642	F	-20.216147
average difference: -12.81689						
t-statistic for testing if this is different than zero: -0.2200733						
p-value: 0.829845						

The predicted values for both models were usually lower than the true values, indicating that there is a non-linear increasing trend during the month of the test promotions that is not accounted for in the model. Because the predicted values are consistently wrong, the models are not reliable.

Diagnostics for the revenue model (presented in Appendix D) indicates that there are two days that may be somehow inherently different from the other days in the study. The removal of these days from the prediction model calculations is one strategy to improve the prediction value of the revenue model. Unfortunately, in this case the model without these points actually performed more poorly than the model that included them, as explored in Appendix F.

IV. Conclusion

Although overall company sales and revenue significantly increase on days in which there is an advertised promotion, analysis of the relationship between sales and revenue and specific promotion characteristics was inconclusive. Informal analysis indicated that there is only weak reliance of overall and product sales and revenue on on any of the variables included in this study, at best; formal analysis confirmed these results.

The best models selected from the available possible predictors indicated general trends in sales and revenue dependent upon promotion variables; from these, good promotions:

- offer a high percent discount (increased sales)
- are at least two days long (increased sales and revenue)
- include home or food products (increased revenue)
- include products priced between $20 and $30 (increased revenue)
- include Wednesday and Thursday (increased revenue)

and bad promotions:

- include products priced over $50 (decreased sales)

- include products priced below $20 or greater than $30 (decreased revenue)
- include body or clothes products (decreased revenue)
- include Tuesday (decreased revenue)

Although most of these items make sense, the decreased revenue due to including Tuesday in the sale may somehow be an artifact of having the majority of the promotions include (and in fact start on) Tuesday.

Unfortunately, these trends can not be validated through a predictive model. For both sales and revenue, predictions were for the most part lower than actual sales and revenue on promotion days; the models somehow do not account for a nonlinear trend in sales and revenue.

The models may be improved by the inclusion of nationwide consumer trend data such as the consumer price index. However, this would not be valuable for real-time predictions since this information is only available until a month or so after it would be needed. More realistic improvements may come with time as seasonal data becomes available and these trends can be accounted for.

While more information may improve the models, it is still apparent that beyond small trends, GMP consumers are largely moved to buy by the existence of a promotion, but are either not affected by the studied promotion components or are a variable enough group to be affected oppositely by the elements, thus washing out their effects. If demographic information on purchasers is available, further study may find practical predictive models based on type of shopper.

V. Credits and References

Many thanks to Brian Junker for his patient assistance in the data analysis for and writing of this report.

Also thanks to Michael for his persistent data collection and Anthony Brockwell for his time series advice.

Rawlings, John L., Sastry G. Bantula and David A. Dickey, *Applied Regression Analysis: A Research Tool,* second edition. Springer: New York, 1989.

S-Plus 2000 Programmer's Guide, Data Analysis Products Division, MathSoft, Seattle, WA.

Venables, W.N. and B.D. Ripley, *Modern Applied Statistics with S-PLUS,* third edition. Springer: New York, 1999.

Appendix A
Glossary

autocorrelation—the dependence of one day's values on previous days' values

aveperc—average percent discount given during a promotion

body—indicator that a product in the "body" category was promoted on this day

cleaning—indicator that a product in the "cleaning" category was promoted on this day

clothes—indicator that a product in the "clothes" category was promoted on this day

d.mon-d.sun—an indicator that a particular day falls on the code day of the week

date—calendar day on which the sale/revenue was make

dos.1-dos.6—an indicator that a day is the code day of the promotion (e.g., dos.1=1 means this day is the first day of a promotion)

dosale—day of the promotion (e.g., the first day of a three-day promotion)

doweek—day of the week, where Sunday=0, Monday=1, etc.

flyers—number of fliers sent to advertise a particular promotion

food—indicator that a product in the "food" category was promoted on this day

fri—an indicator that the promotion a particular day is part of includes a Friday

highperc—highest percent discount given during a promotion

home—indicator that a product in the "home" category was promoted on this day

is.sale—an indicator for a promotion taking place on a particular day

jan-dec—an indicator that a particular day falls in the code month

length—the length of the promotion in days

mon—an indicator that the promotion a particular day is part of includes a Monday

month—month of the promotion

numprods—number of products on sale during a promotion

p-value—the probability of getting the data if what you are trying to prove is false

price1—indicator that a product that ordinarily costs $10 or less is promoted

price2—indicator that a product that ordinarily costs $10-$20 is promoted

price3—indicator that a product that ordinarily costs $20-$30 is promoted

price4—indicator that a product that ordinarily costs $30-$50 is promoted

price5—indicator that a product that ordinarily costs over $50 is promoted

revenue—value of orders placed on a particular day

sales—number of orders placed on a particular day

sat.sun—an indicator that the promotion a particular day is part of includes a Saturday and Sunday sqrtrevenue—square root of revenue

sqrtsales—square root of sales

start.mon—an indicator that the promotion a particular day is part of began on a Monday

start.sat—an indicator that the promotion a particular day is part of began on a Saturday

start.thu—an indicator that the promotion a particular day is part of began on a Thursday

start.tue—an indicator that the promotion a particular day is part of began on a Tuesday

start.wed—an indicator that the promotion a particular day is part of began on a Wednesday

thu—an indicator that the promotion a particular day is part of includes a Thursday

tue—an indicator that the promotion a particular day is part of includes a Tuesday

wed—an indicator that the promotion a particular day is part of includes a Wednesday

xmas—an indicator for Christmas day

Appendix B
Plots of Determinants for Overall Sales and Revenue

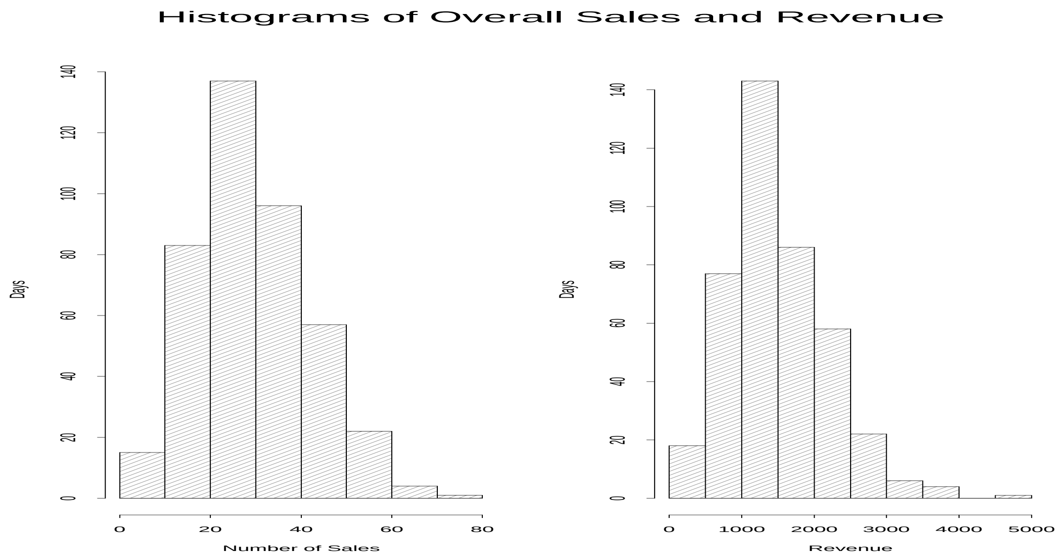

Figure 11: Histograms of Overall Sales and Revenue

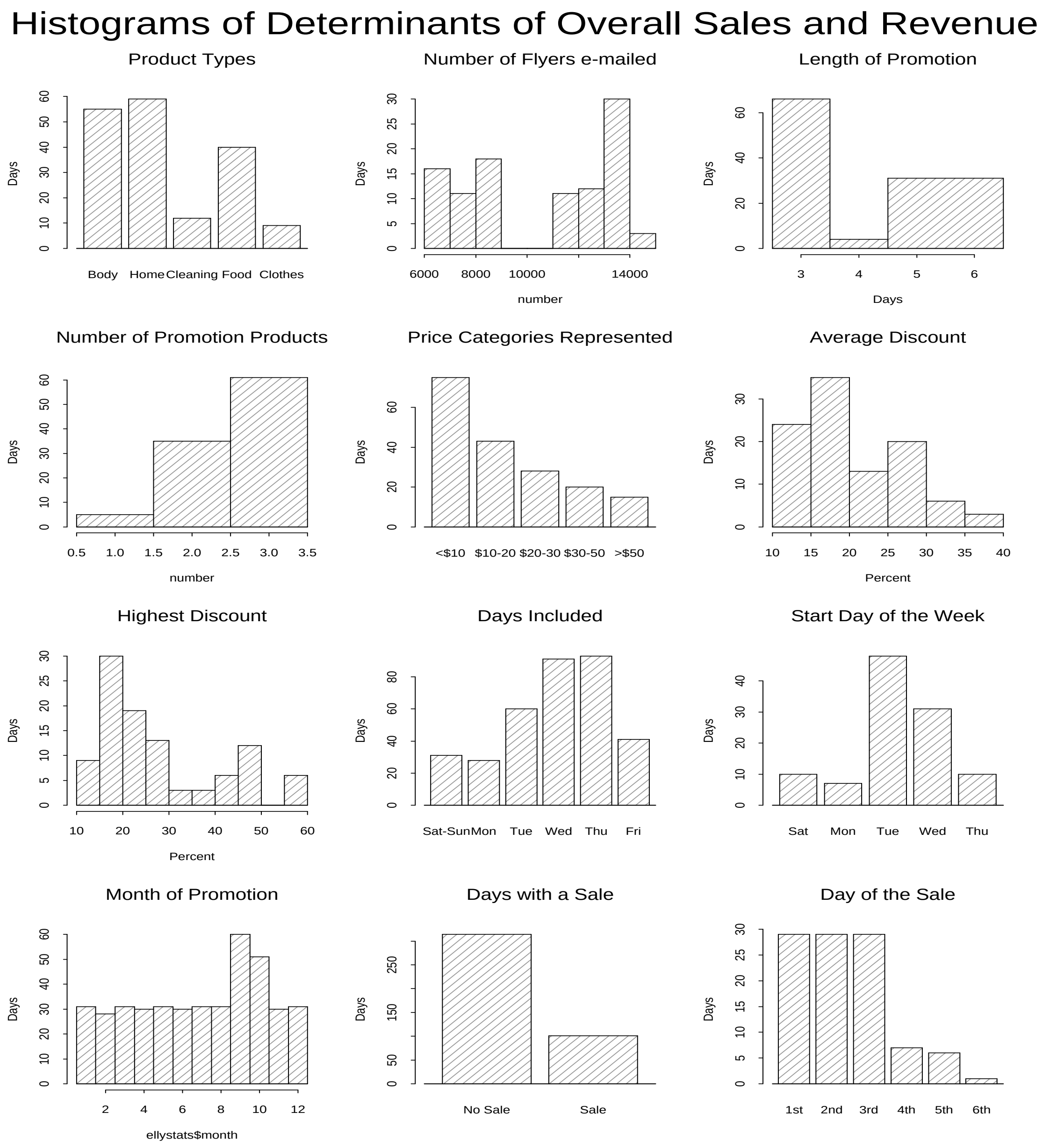

Figure 12: Histograms of Studied Determinants of Overall Sales and Revenue

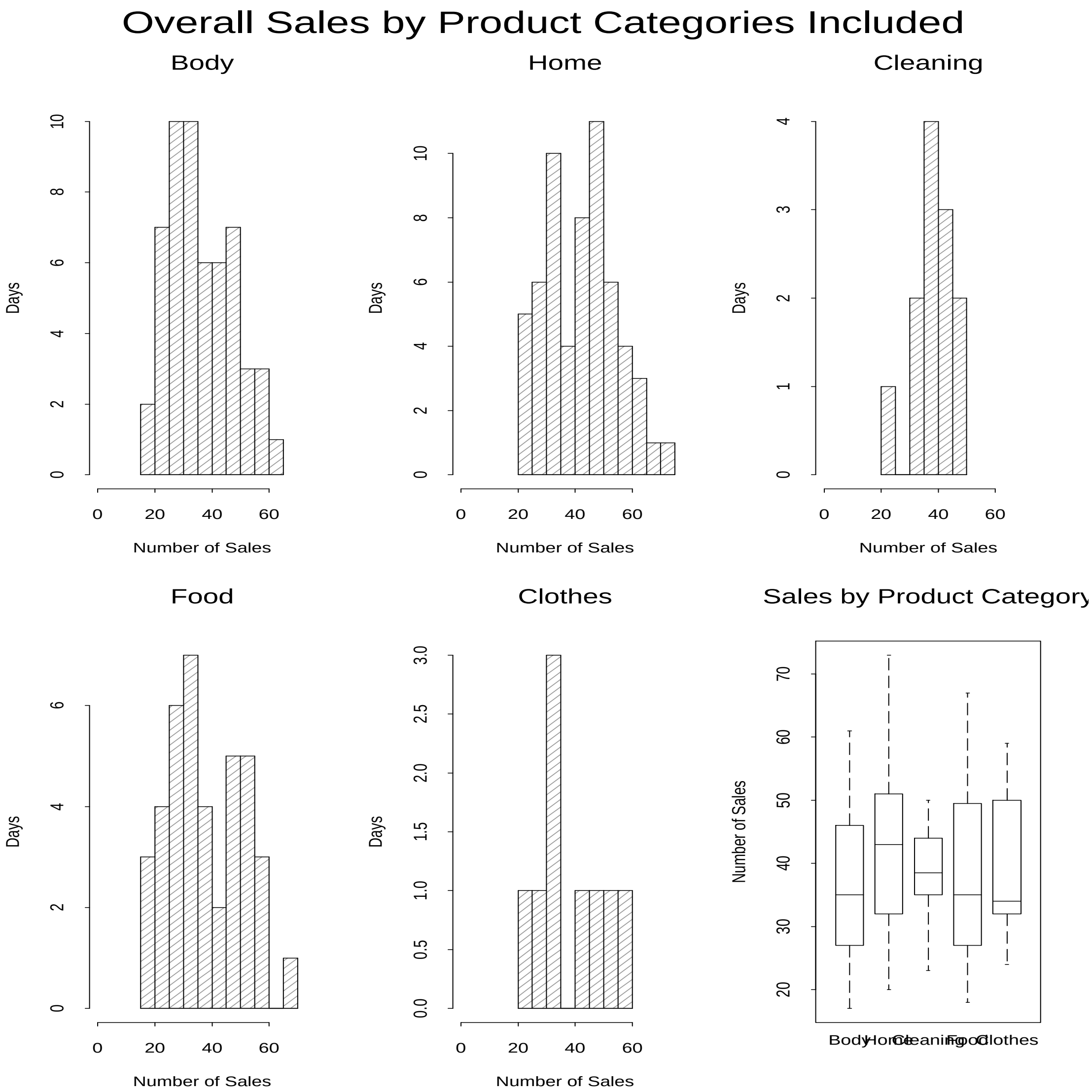

Figure 13: Overall Sales by Product Category Represented in the Promotion

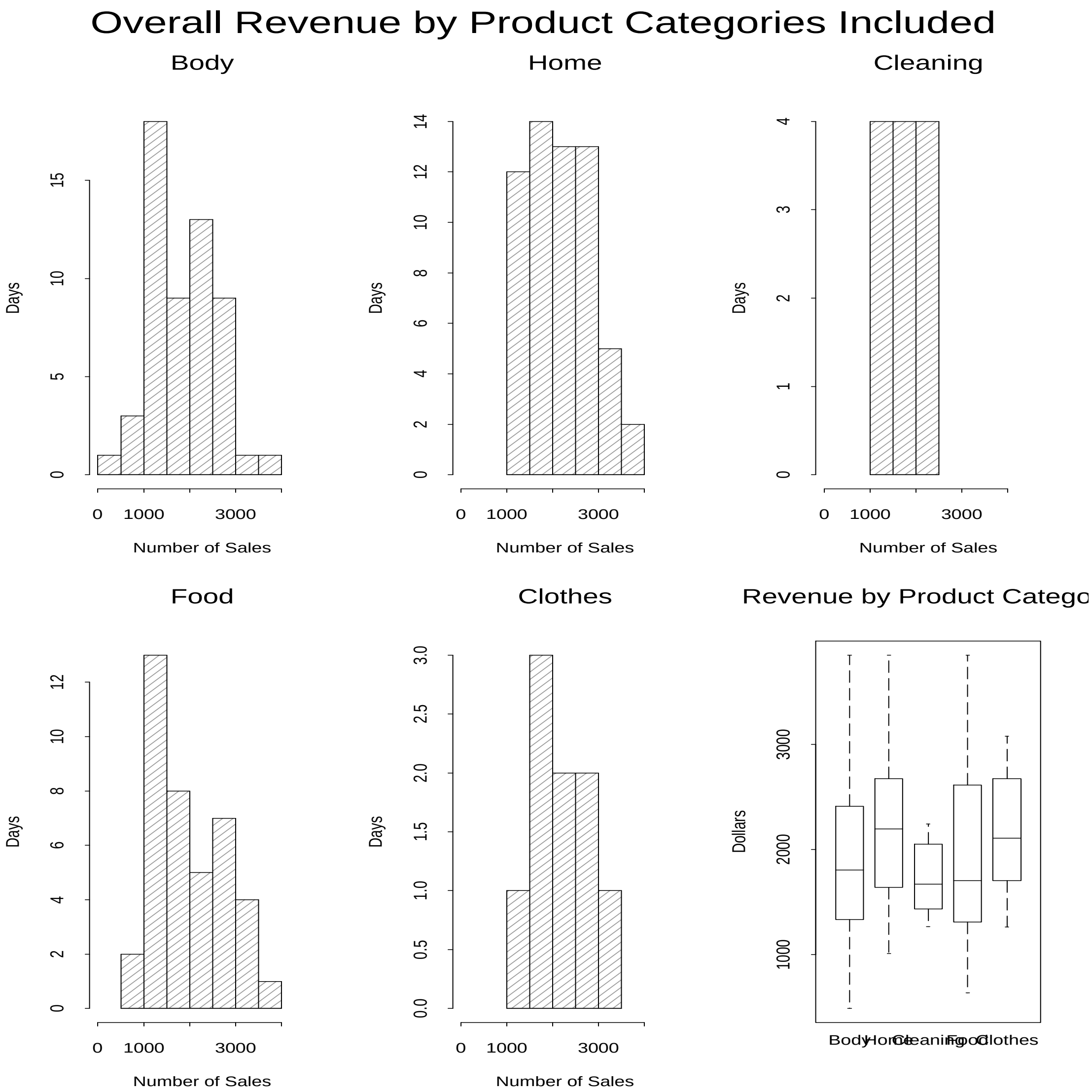

Figure 14: Overall Revenue by Product Category Represented in the Promotion

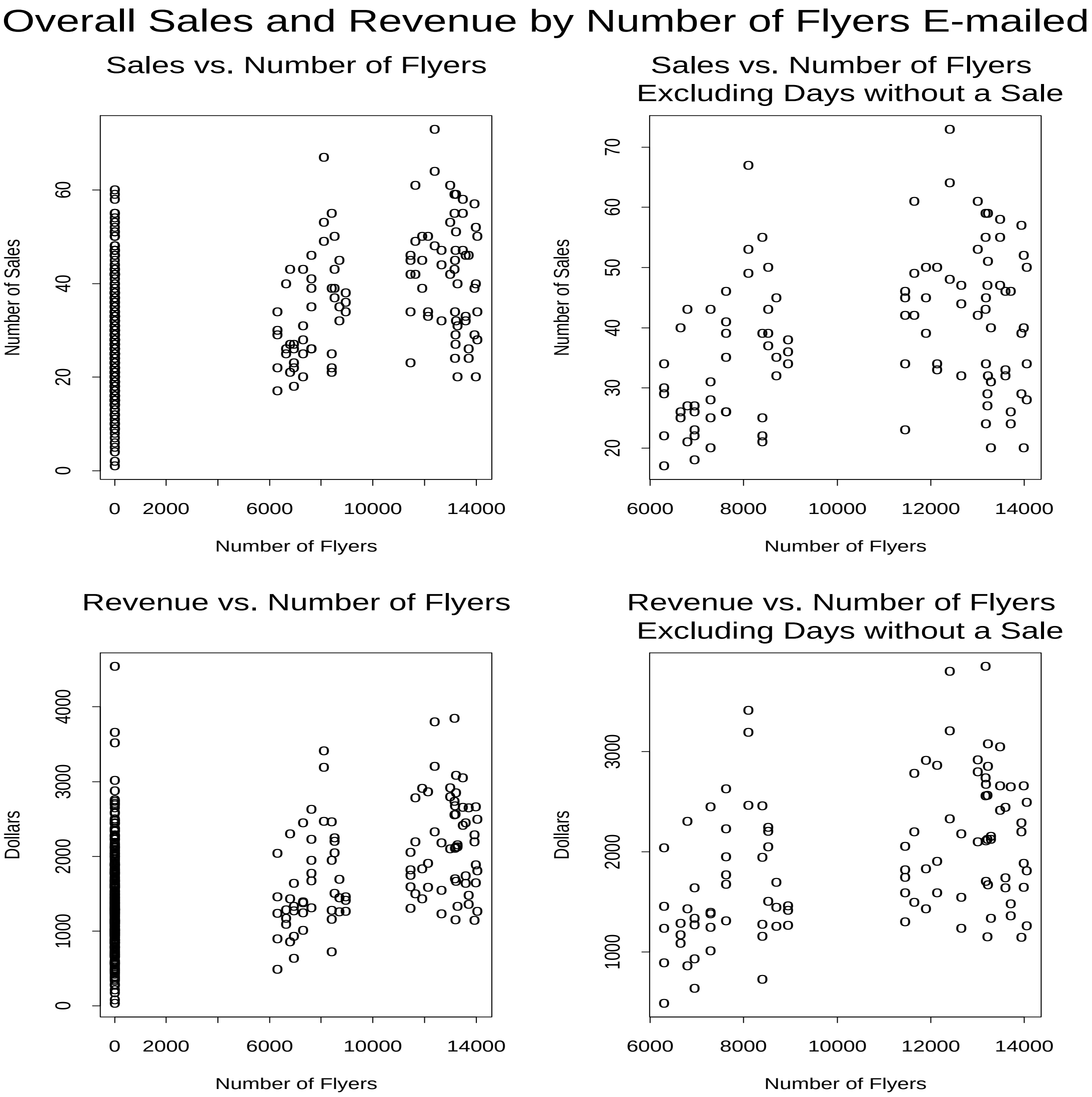

Figure 15: Overall Sales and Revenue by Number of Flyers E-mailed

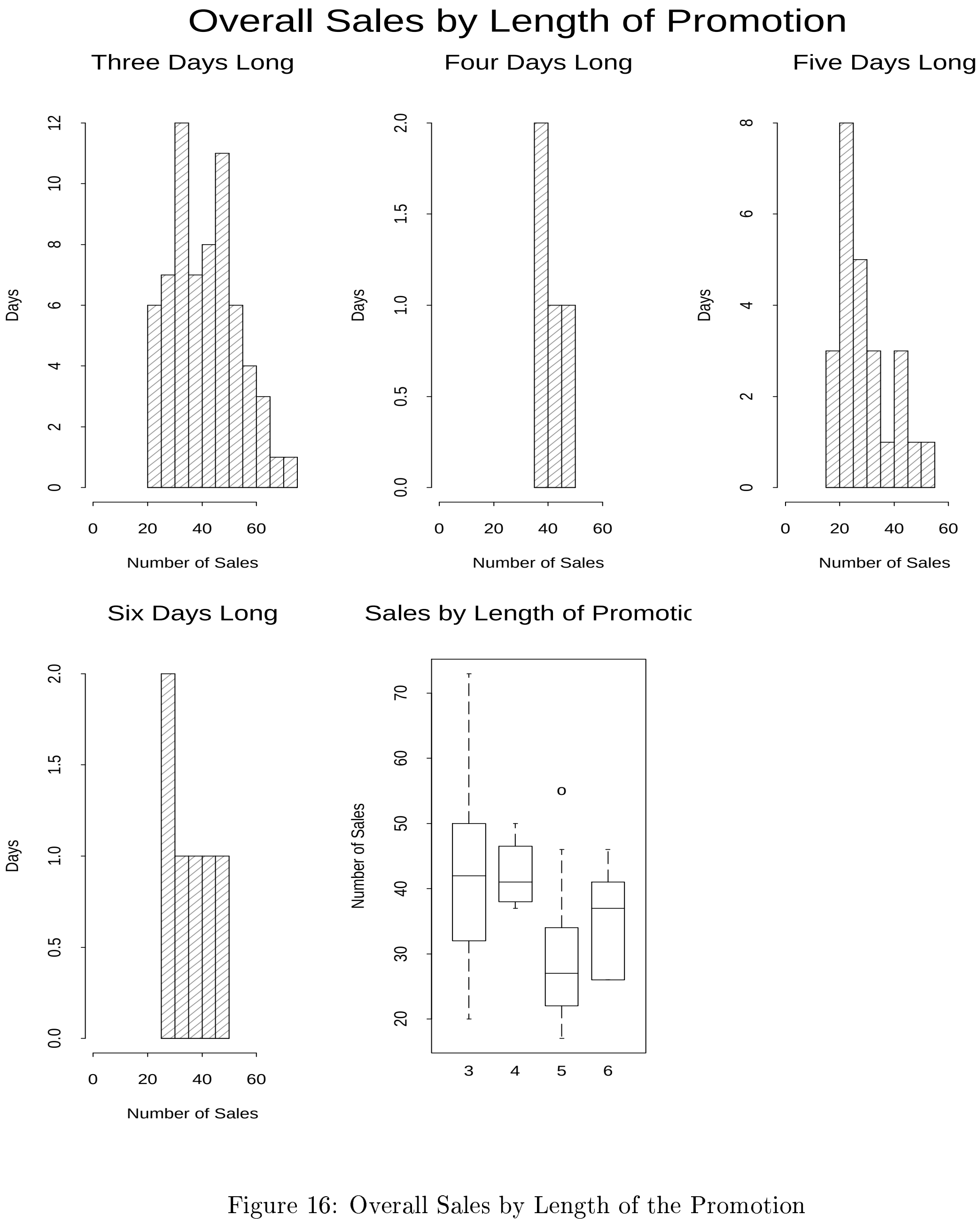

Figure 16: Overall Sales by Length of the Promotion

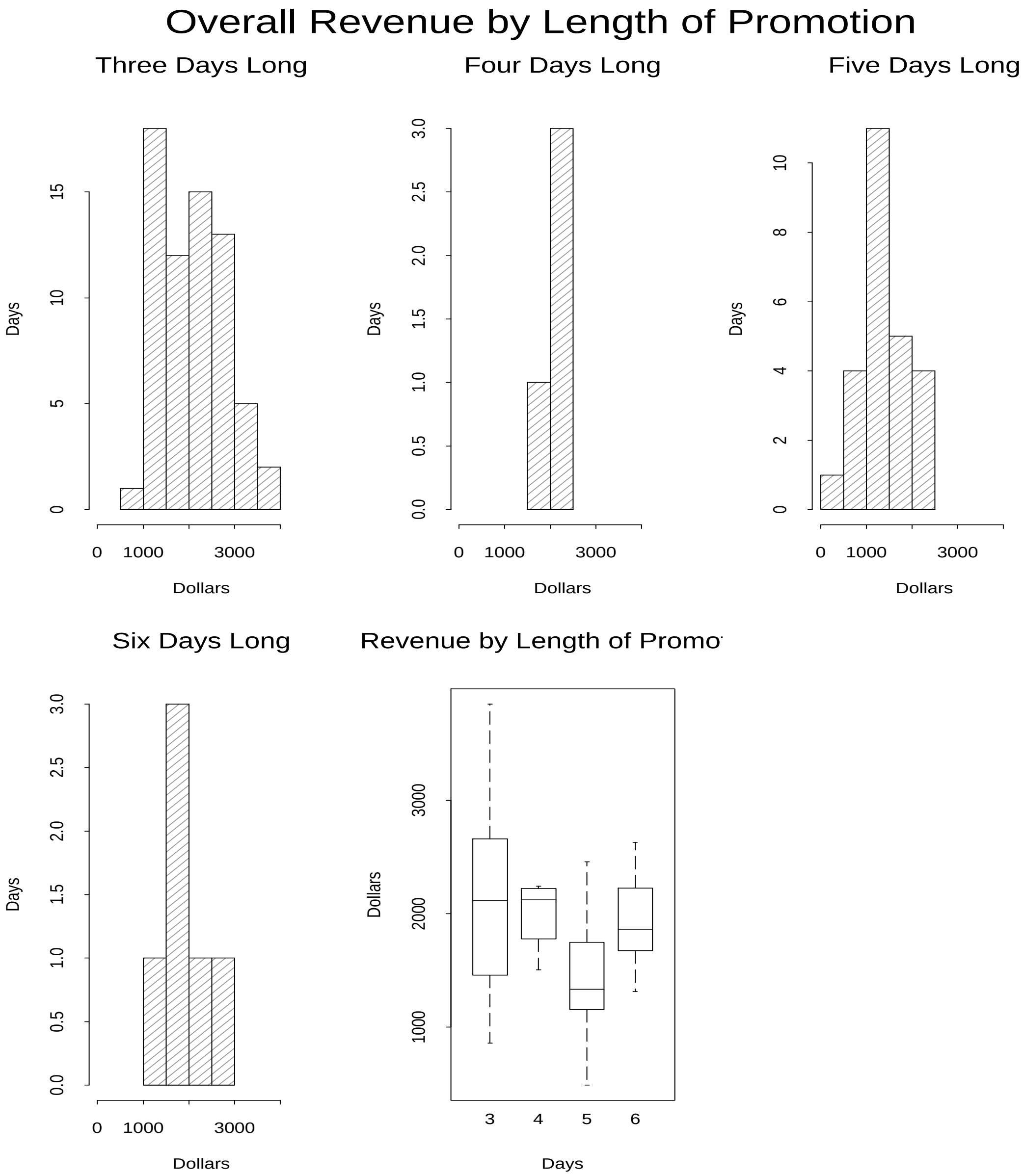

Figure 17: Overall Revenue by Length of the Promotion

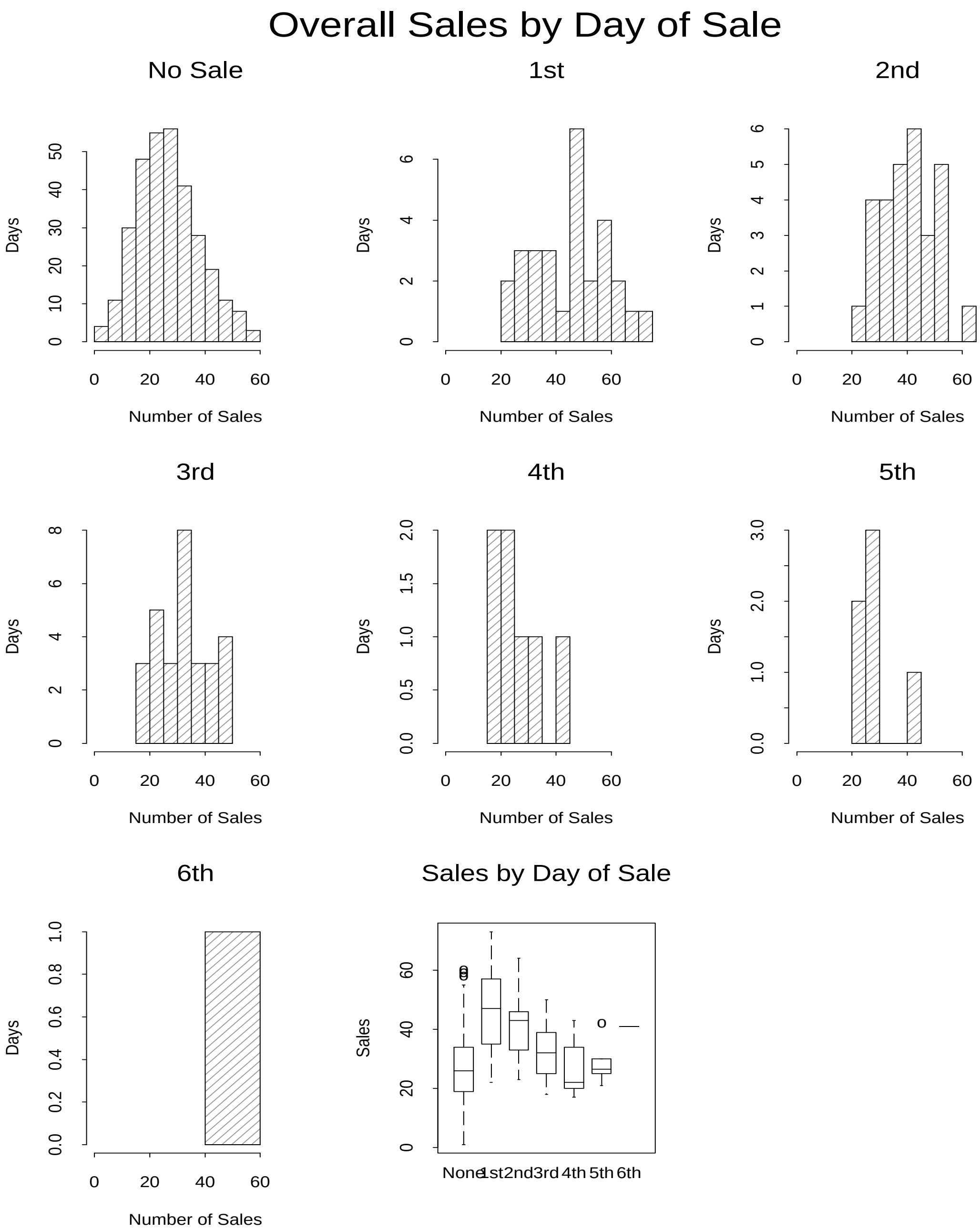

Figure 18: Overall Sales by Day of the Promotion

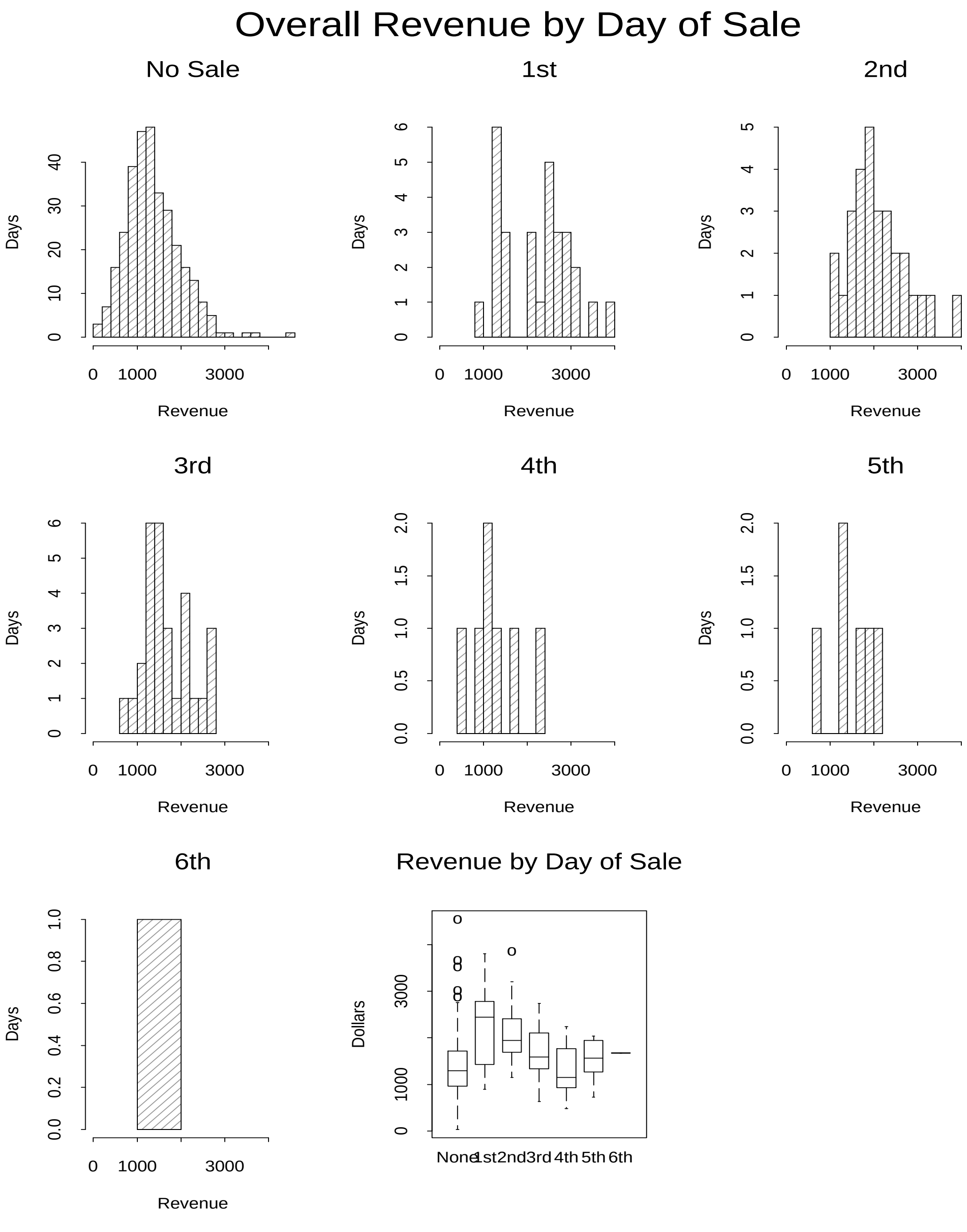

Figure 19: Overall Revenue by Day of the Promotion

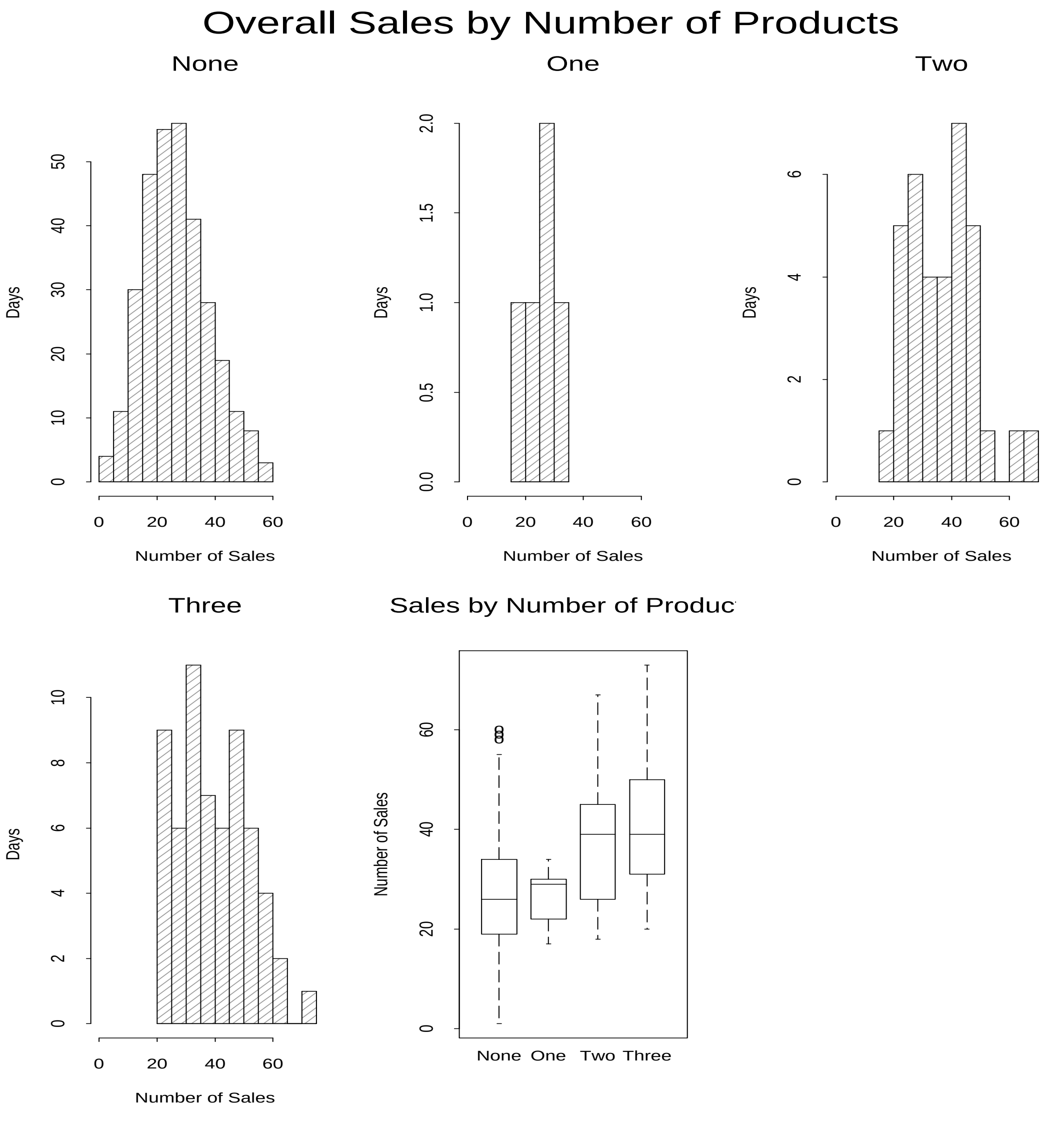

Figure 20: Overall Sales by Number of Products In the Promotion

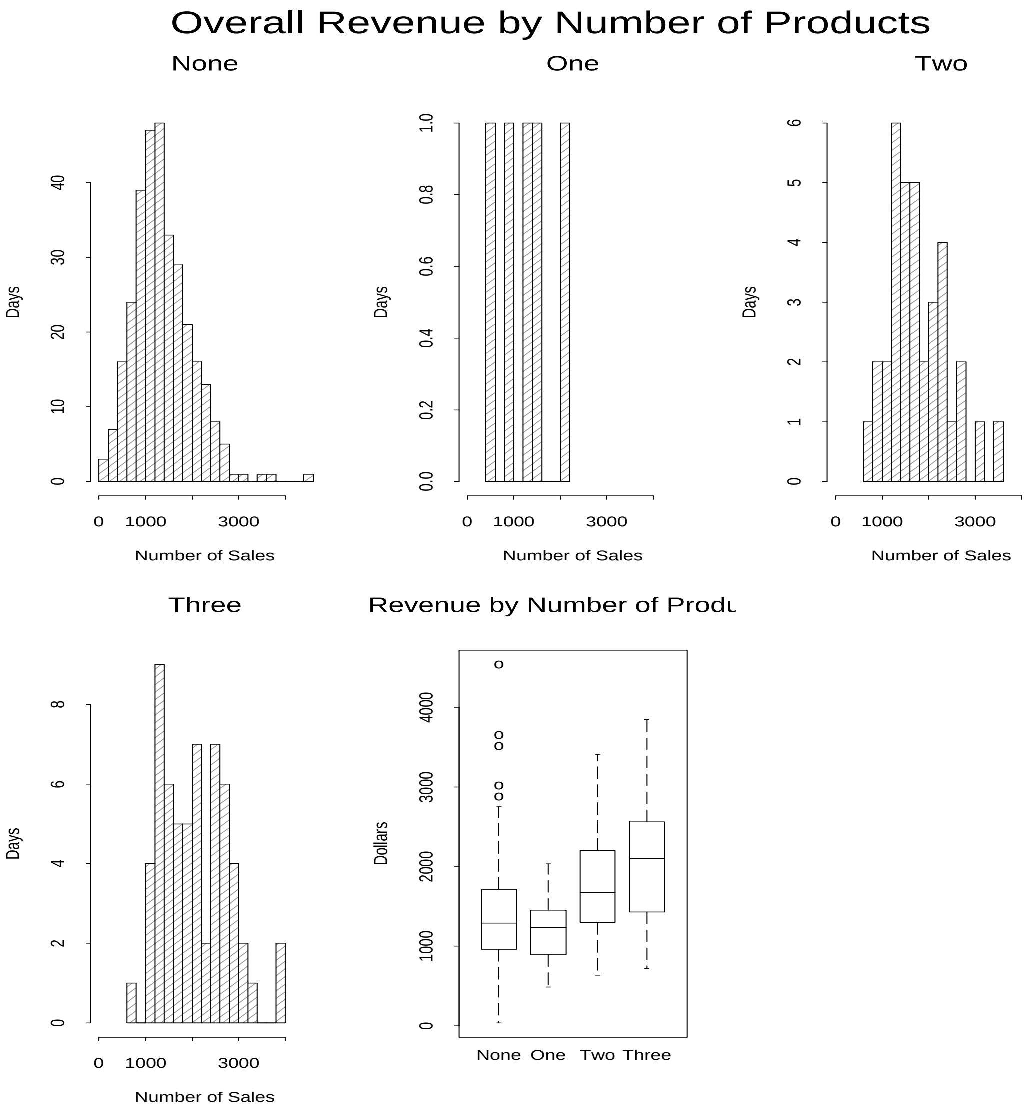

Figure 21: Overall Revenue by Number of Products In the Promotion

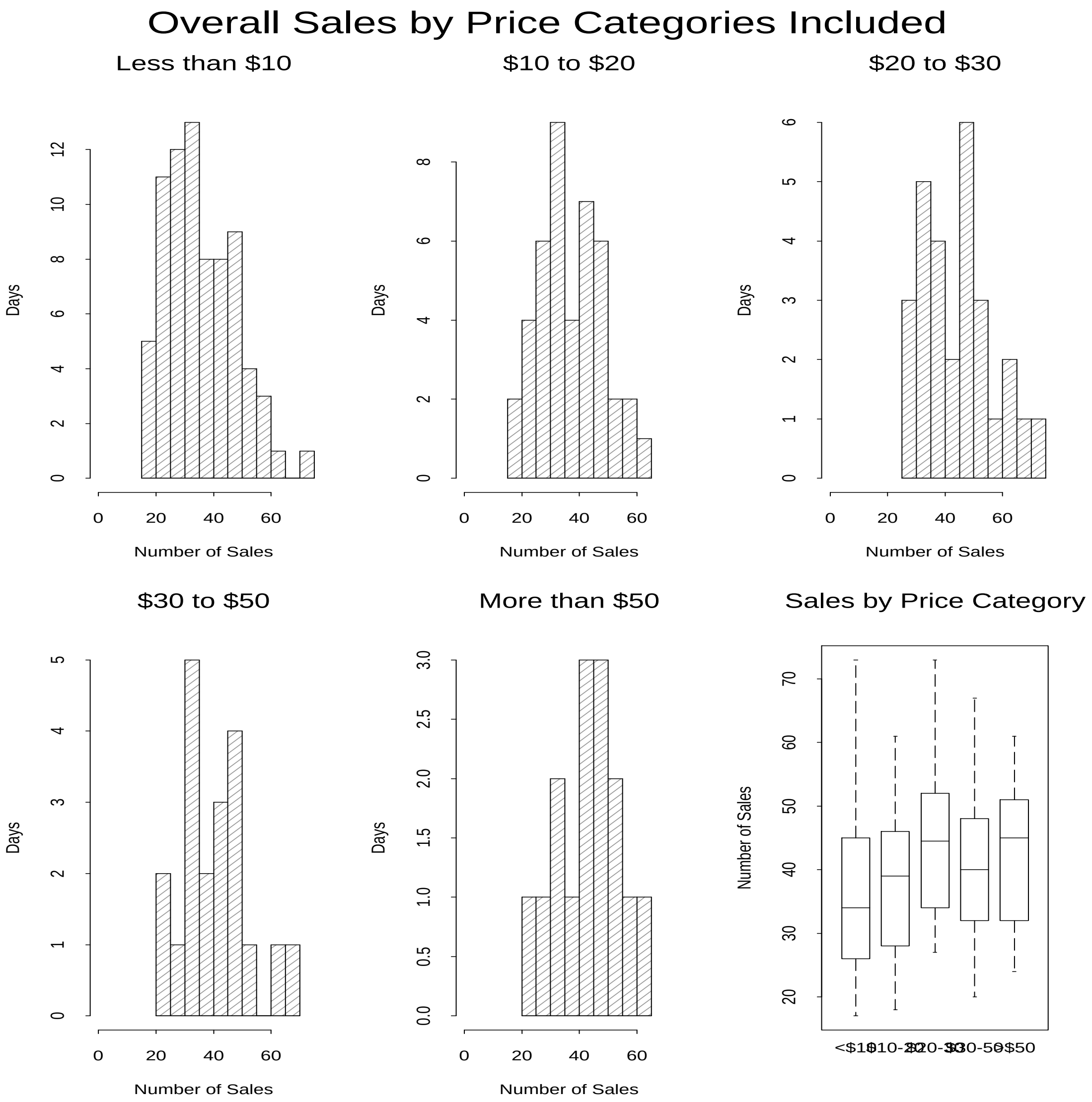

Figure 22: Overall Sales by Price Categories Represented In the Promotion

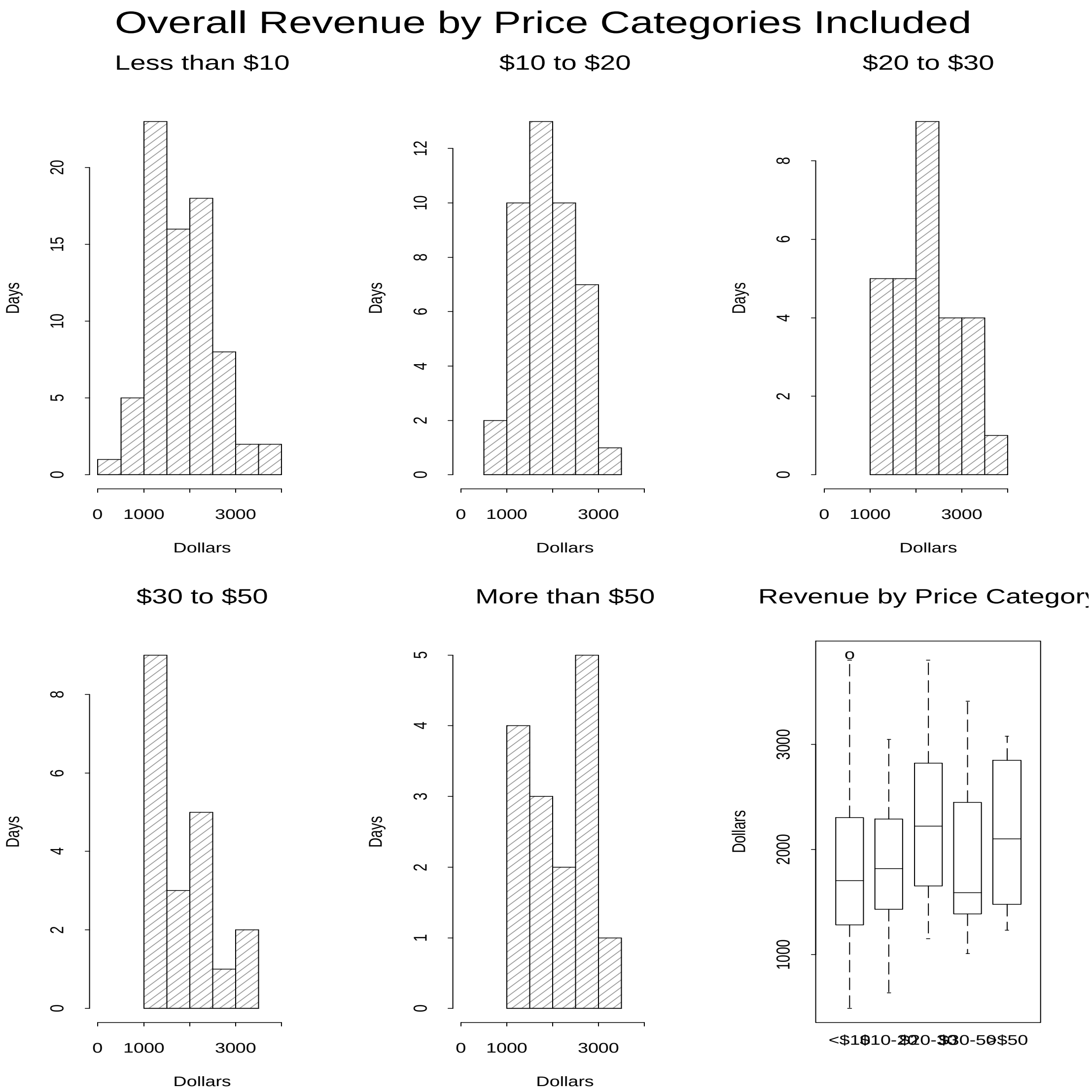

Figure 23: Overall Revenue by Price Categories Represented in the Promotion

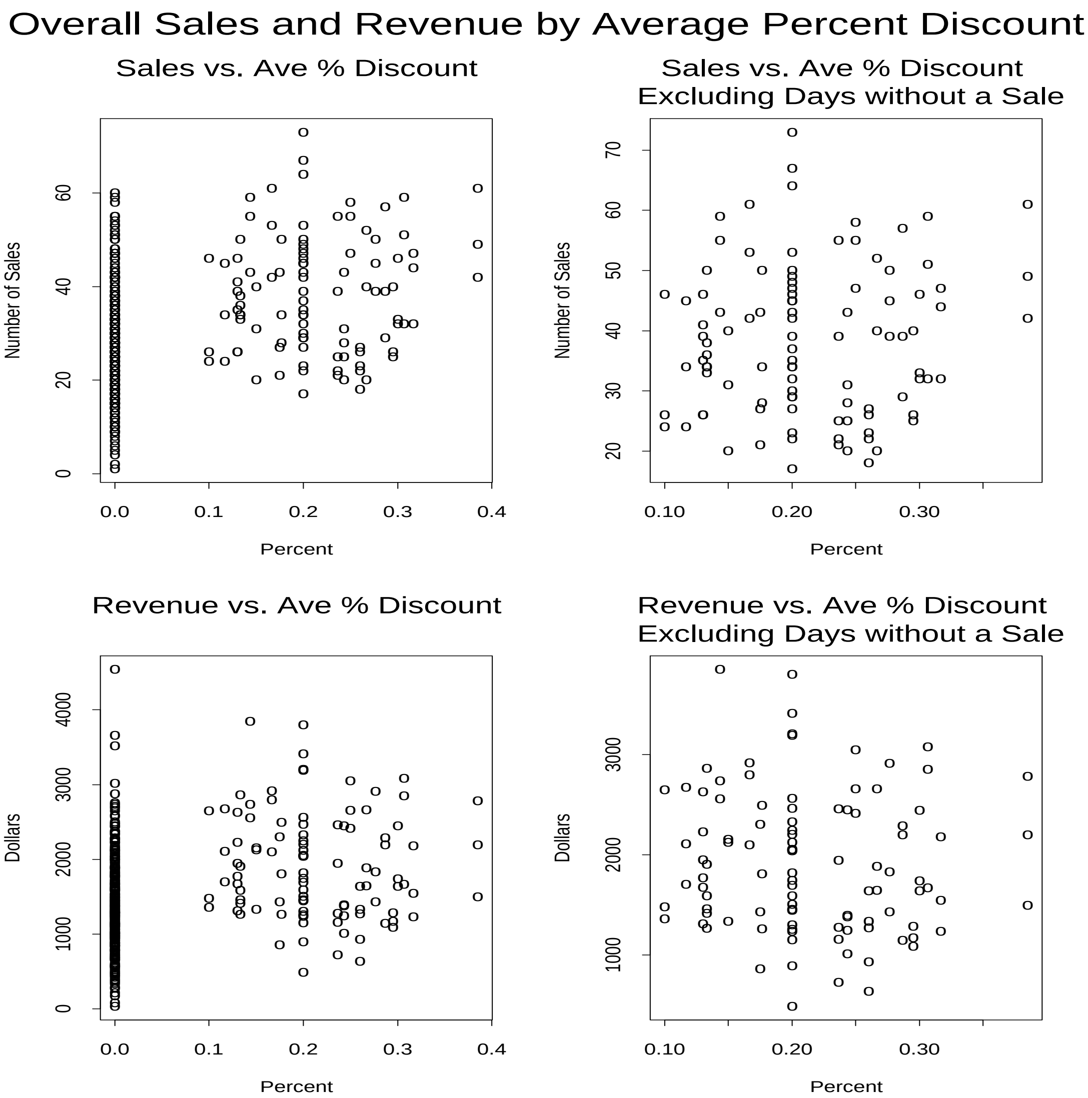

Figure 24: Overall Sales and Revenue by Average Percent Discount During the Promotion

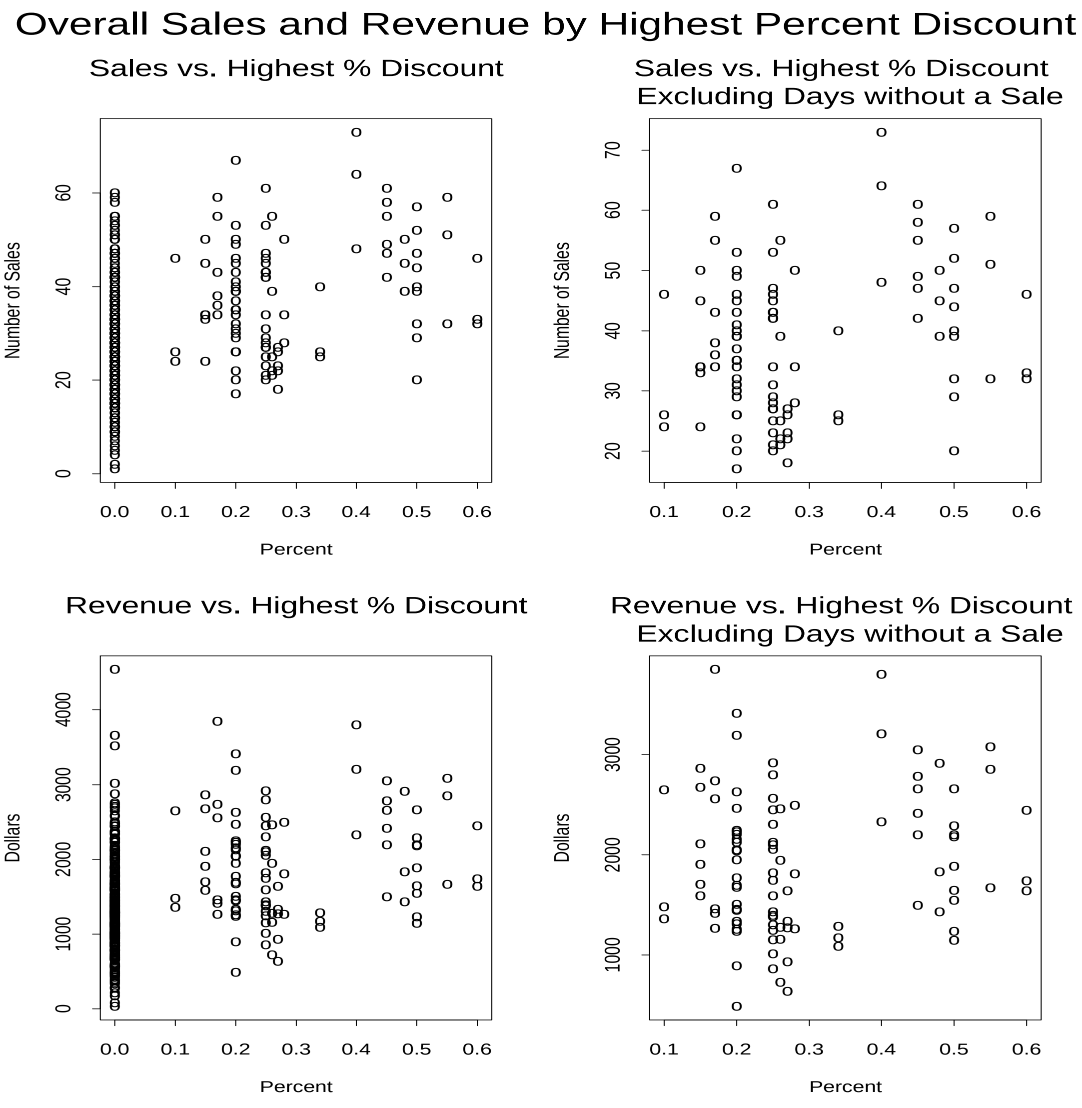

Figure 25: Overall Sales and Revenue by Highest Percent Discount During the Promotion

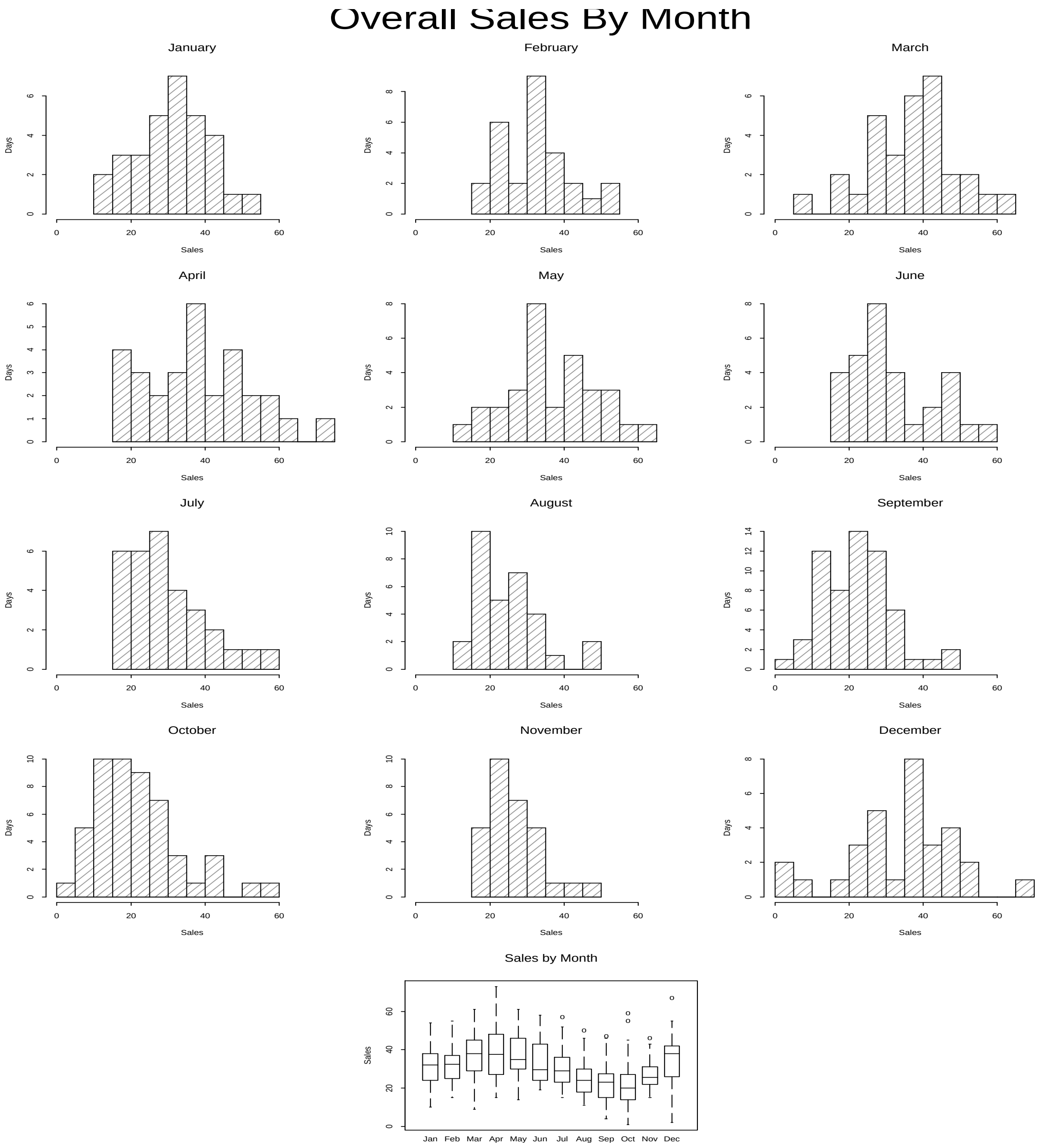

Figure 26: Overall Sales by Month

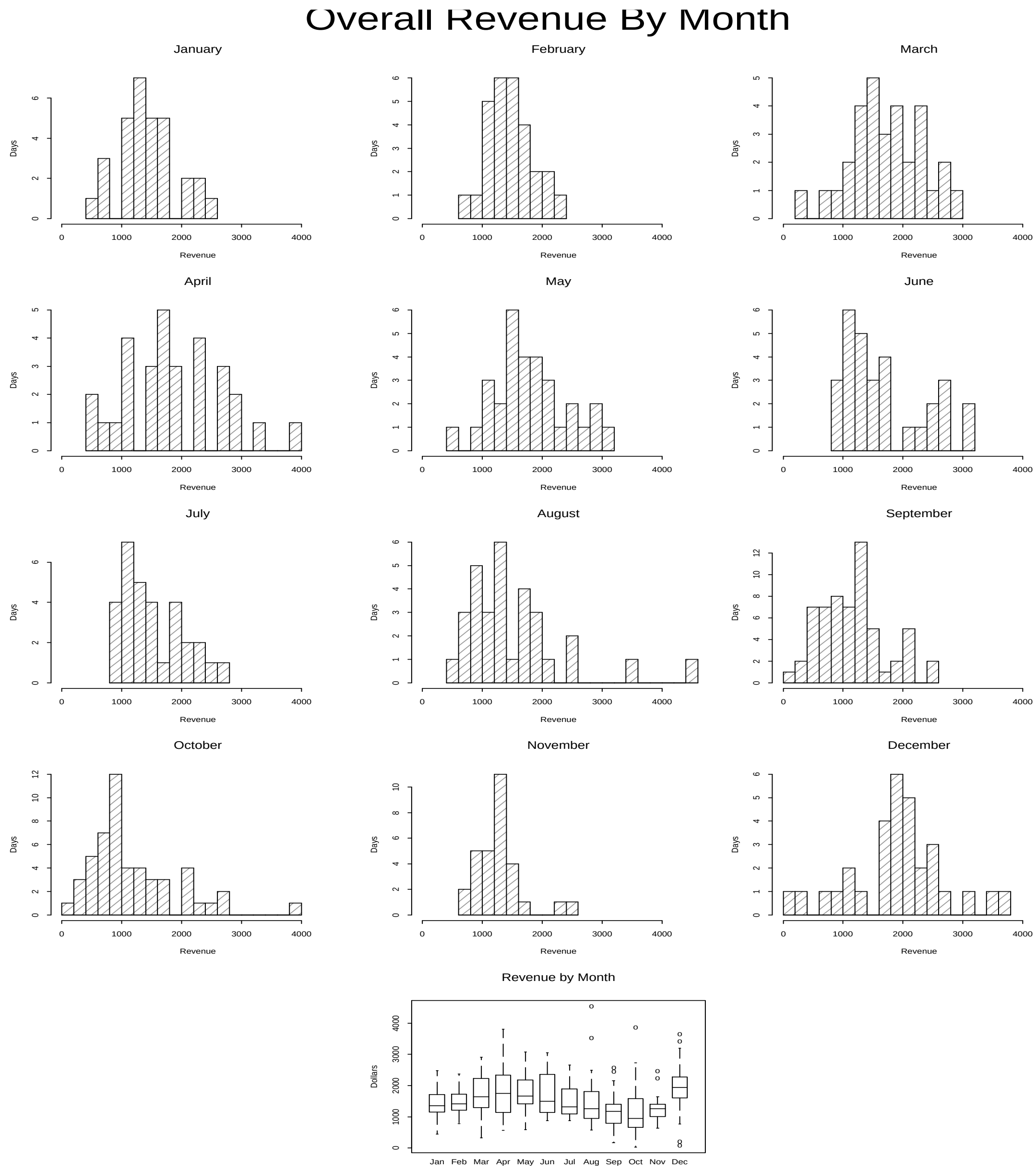

Figure 27: Overall Revenue by Month

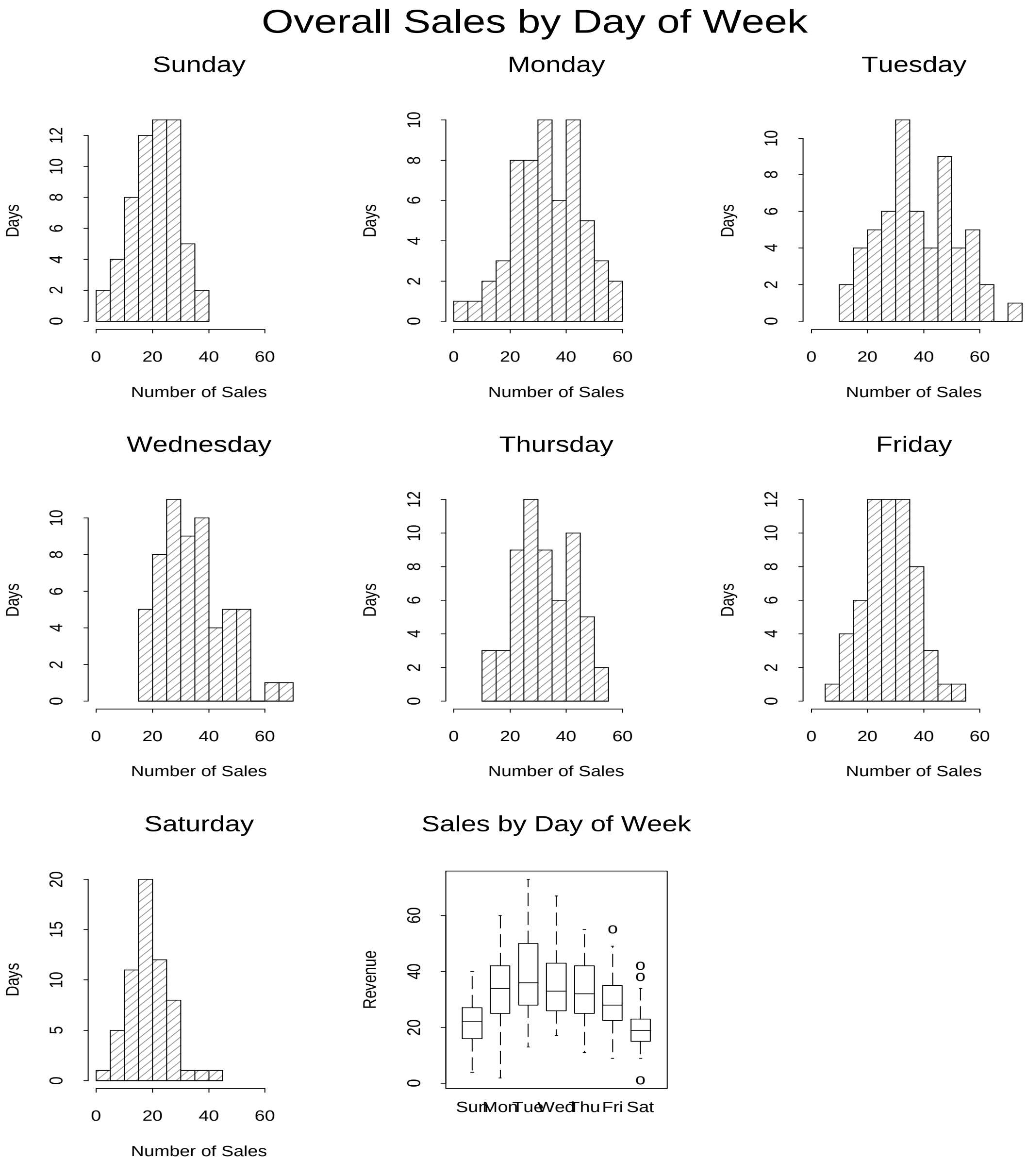

Figure 28: Overall Sales by Day of the Week

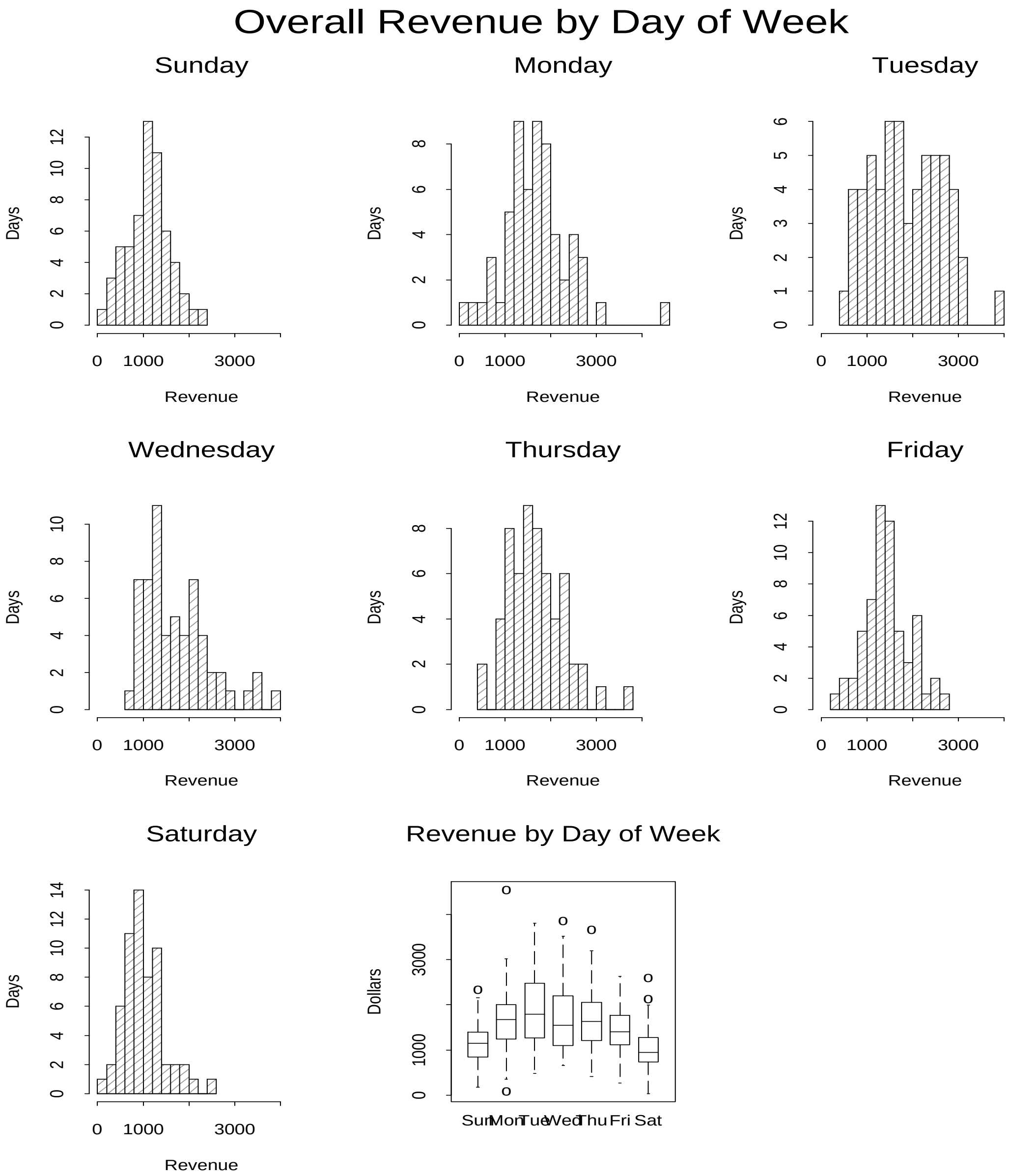

Figure 29: Overall Revenue by Day of the Week

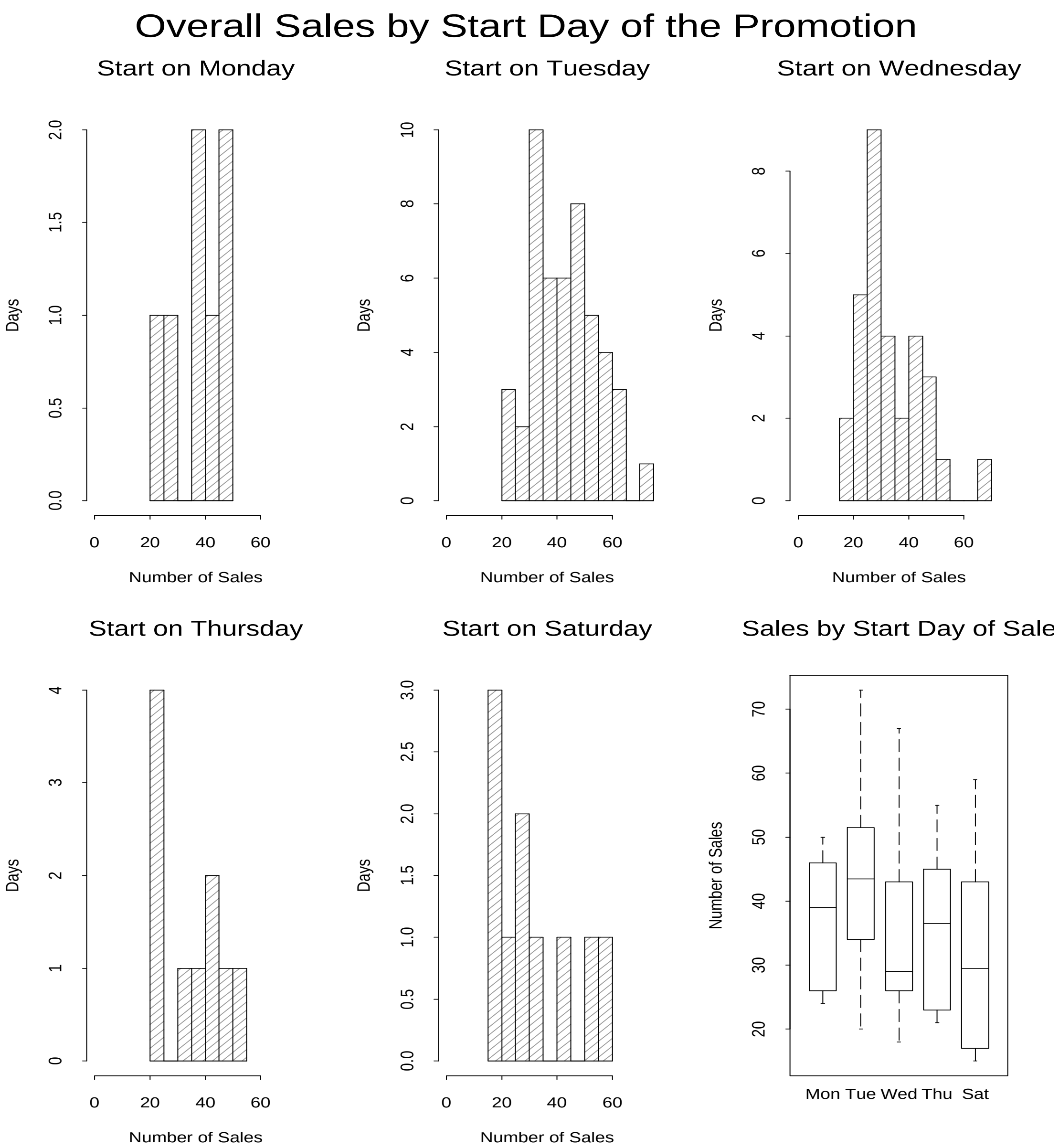

Figure 30: Overall Sales by Starting Day of the Promotion

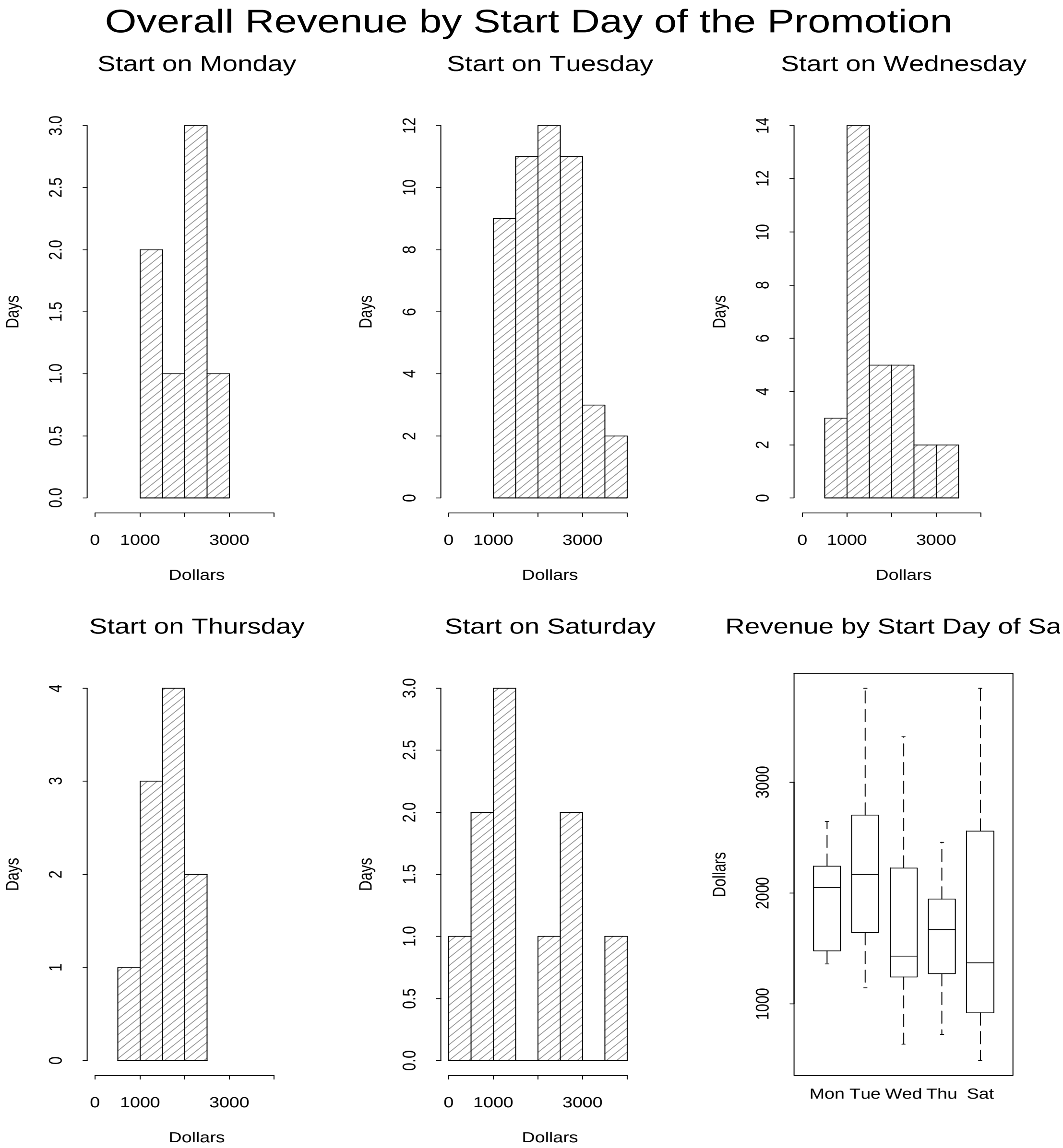

Figure 31: Overall Revenue by Starting Day of the Promotion

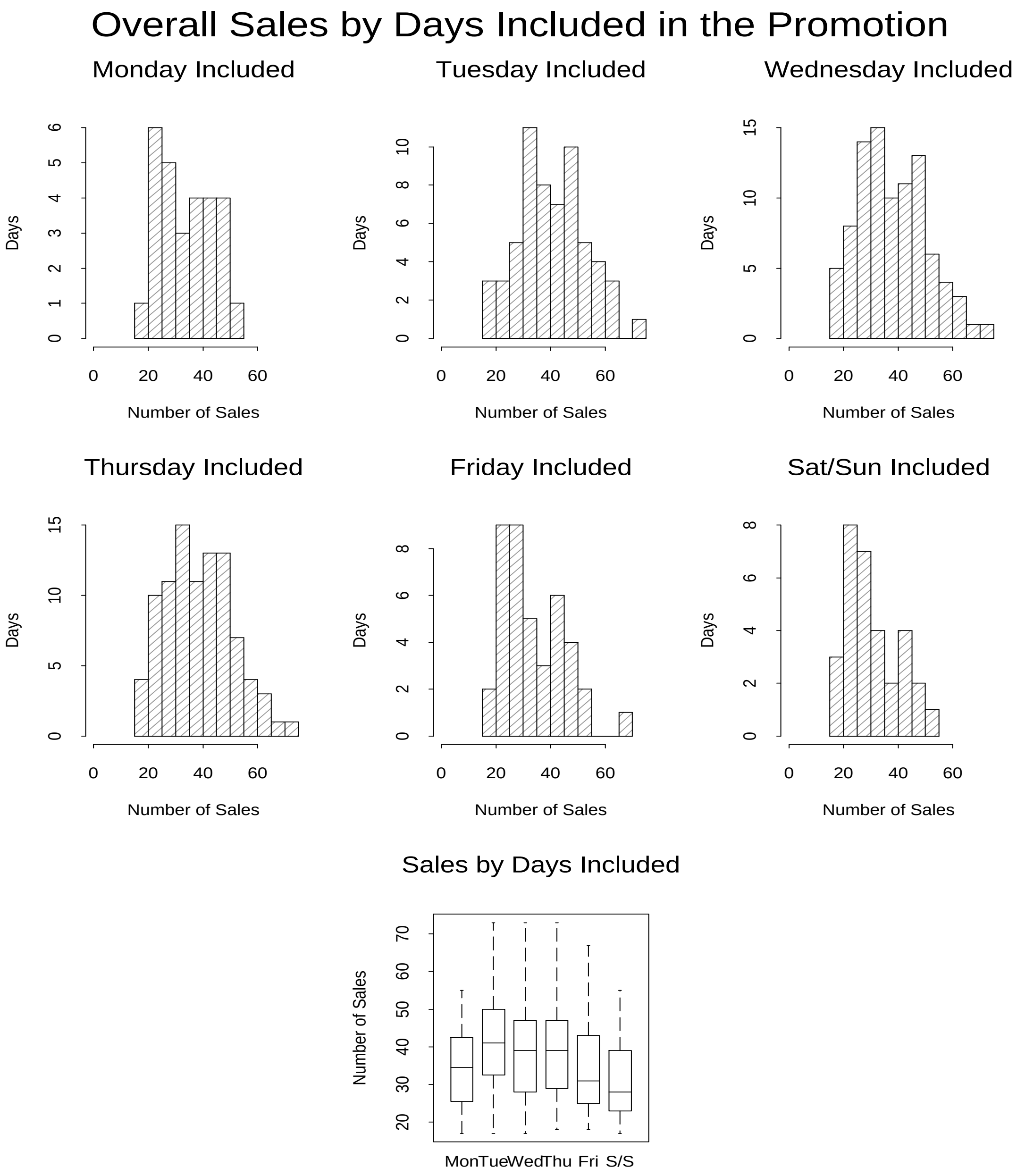

Figure 32: Overall Sales by Days Included in the Promotion

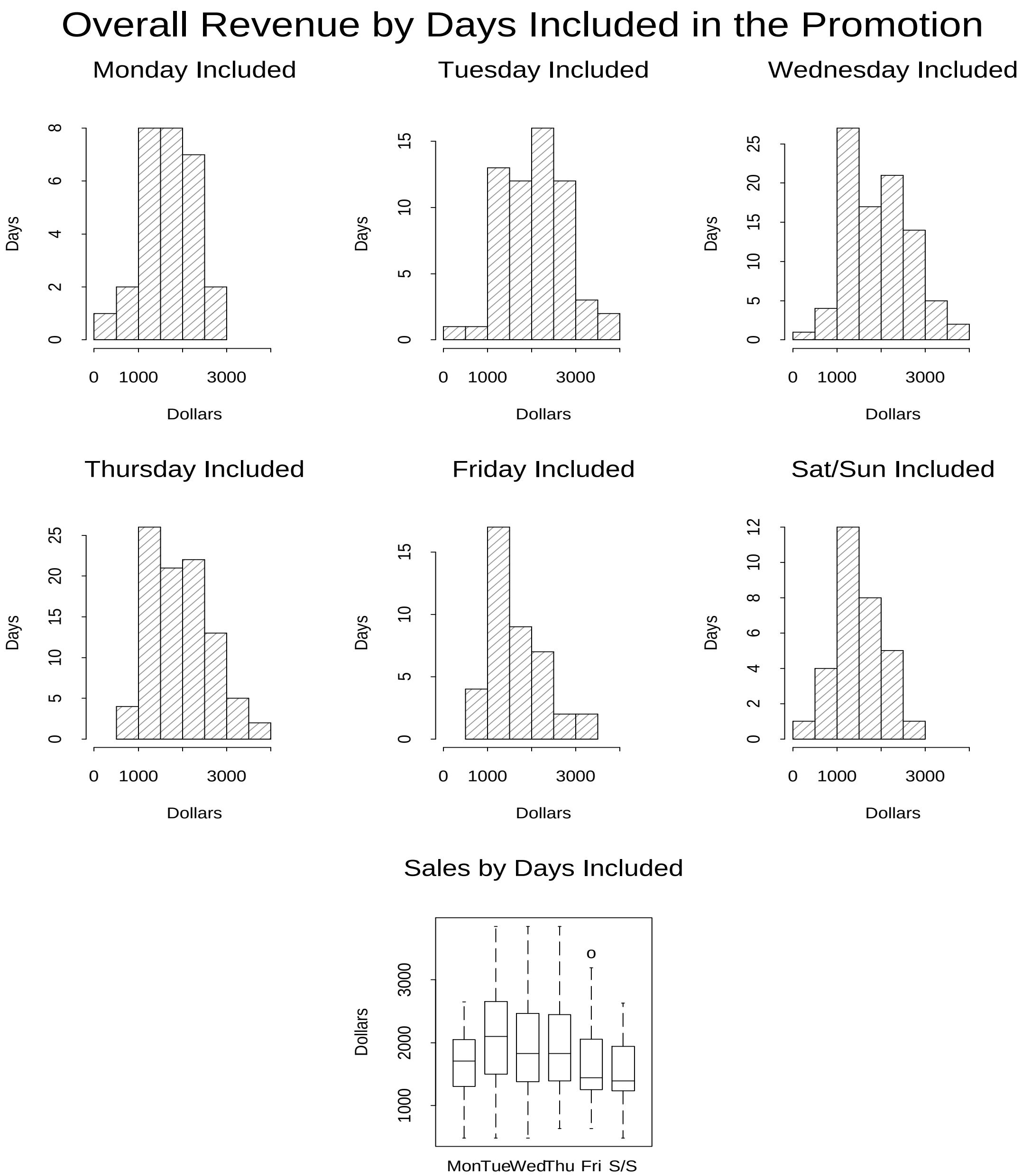

Figure 33: Overall Revenue by Days Included in the Promotion

Appendix C
Plots of Determinants for Product Sales and Revenue

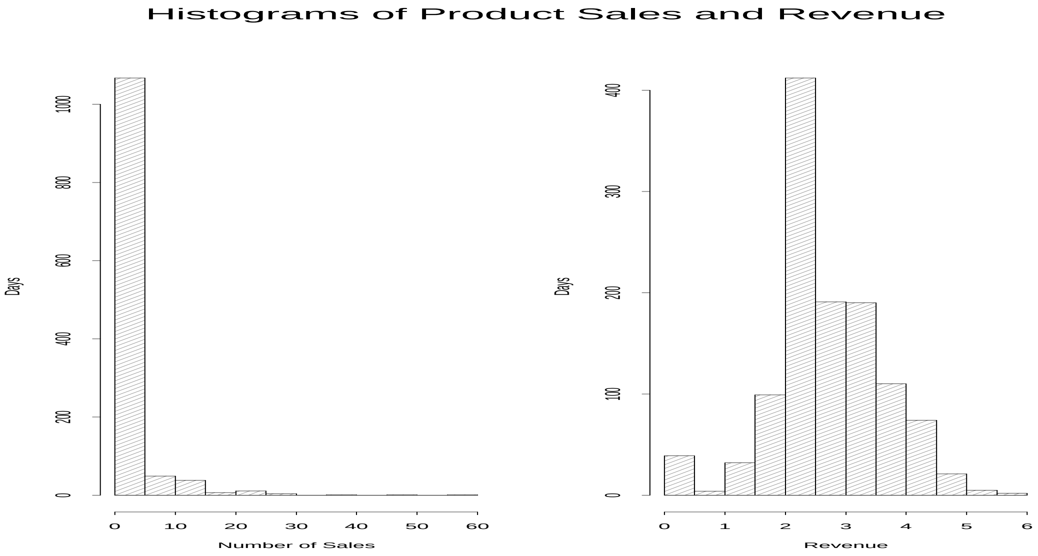

Figure 34: Histograms of Product Sales and Revenue

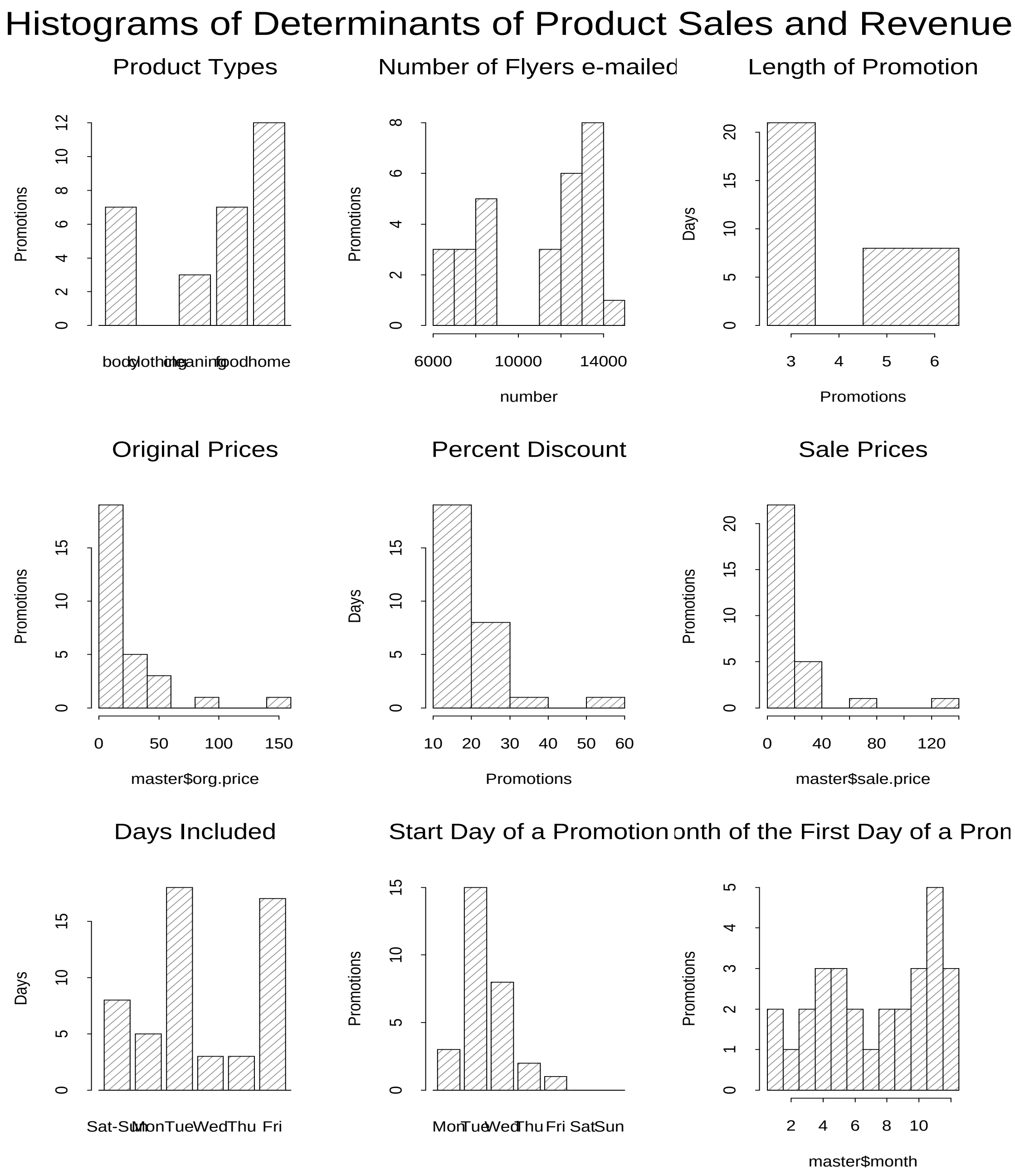

Figure 35: Histograms of Determinants of Product Sales and Revenue

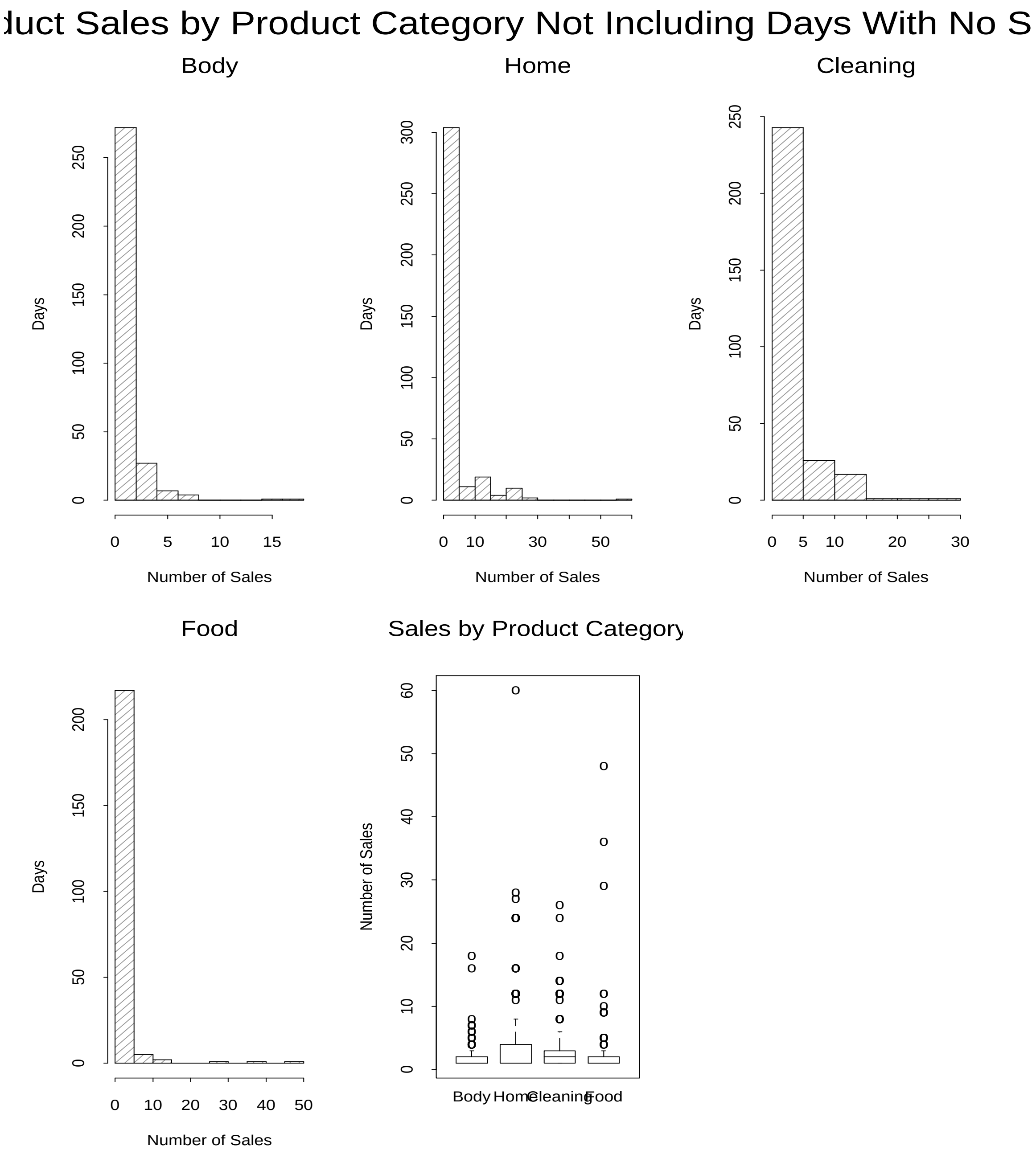

Figure 36: Product Revenue by Category Not Including Days with No Sales

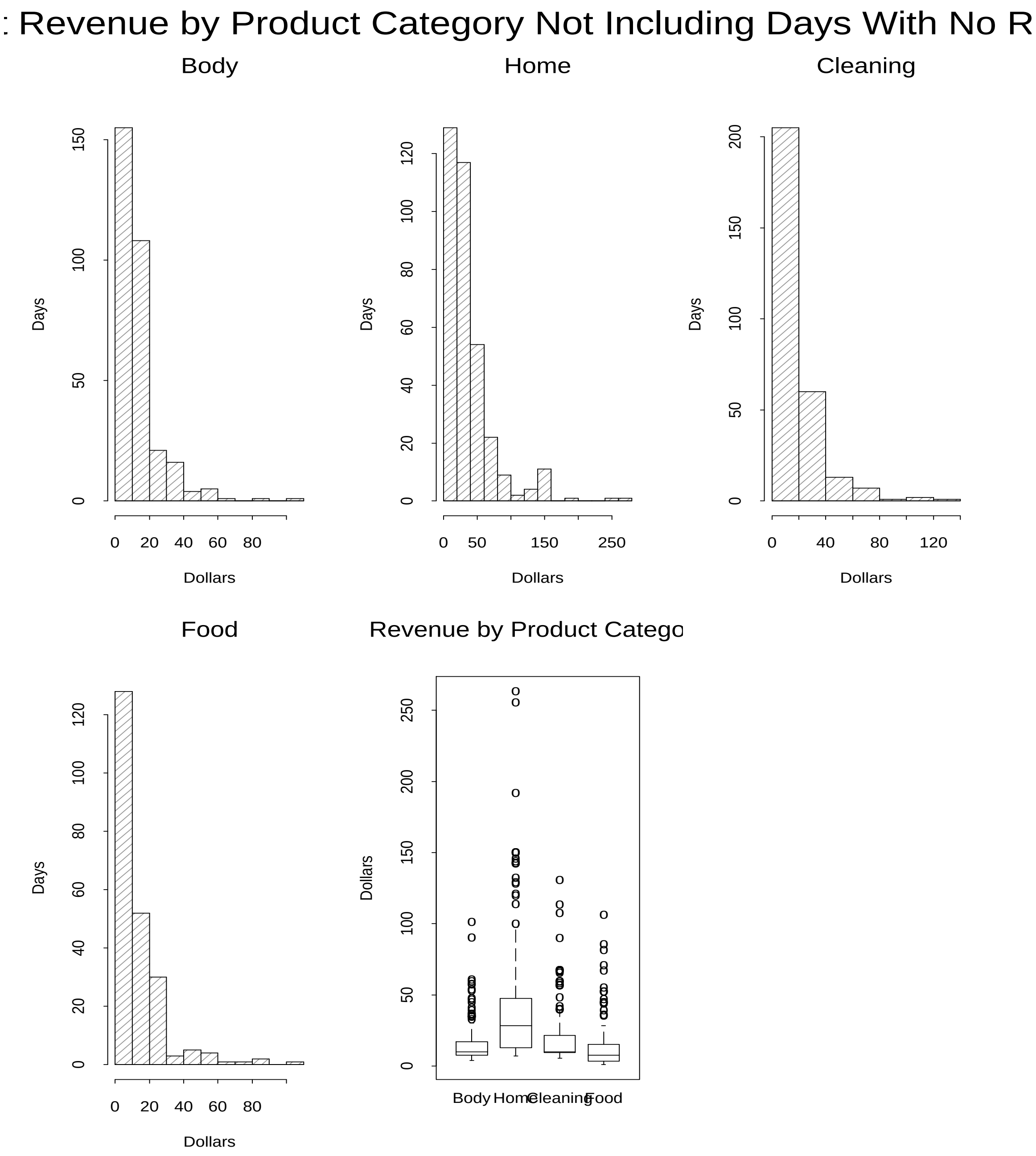

Figure 37: Product Revenue by Category Not Including Days with No Revenue

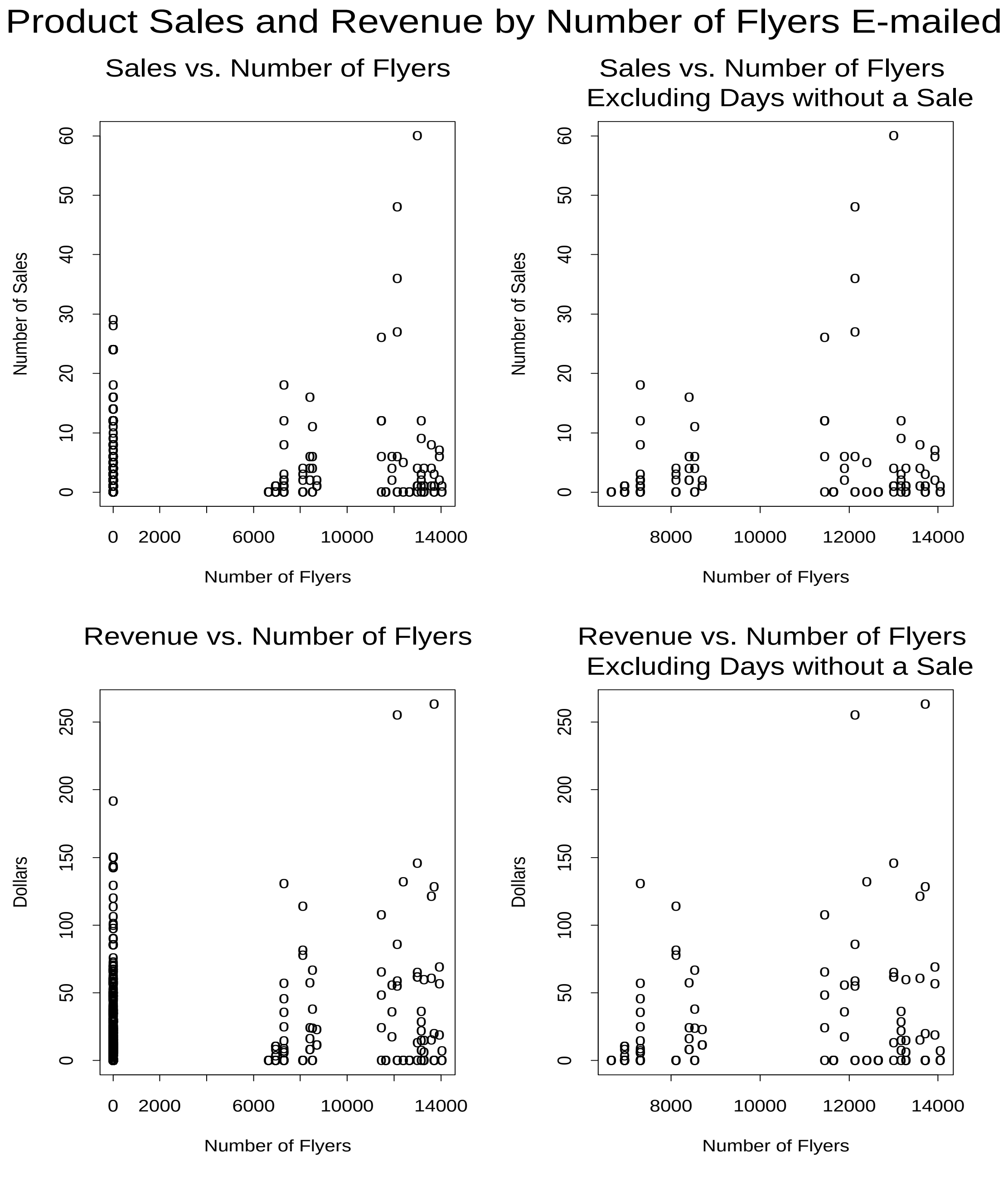

Figure 38: Product Sales and Revenue by Number of Flyers E-mailed

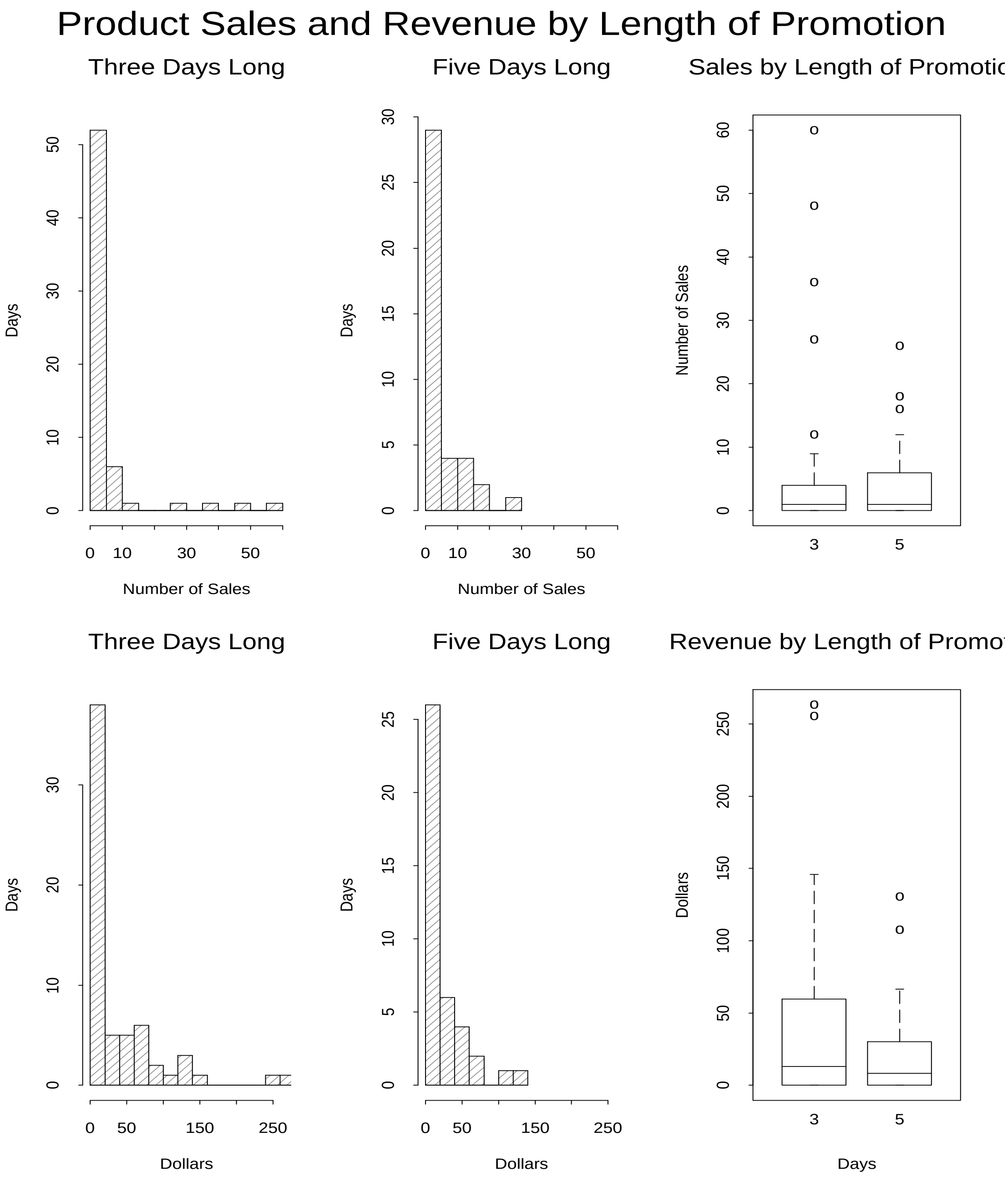

Figure 39: Product Sales and Revenue by Length of Promotion

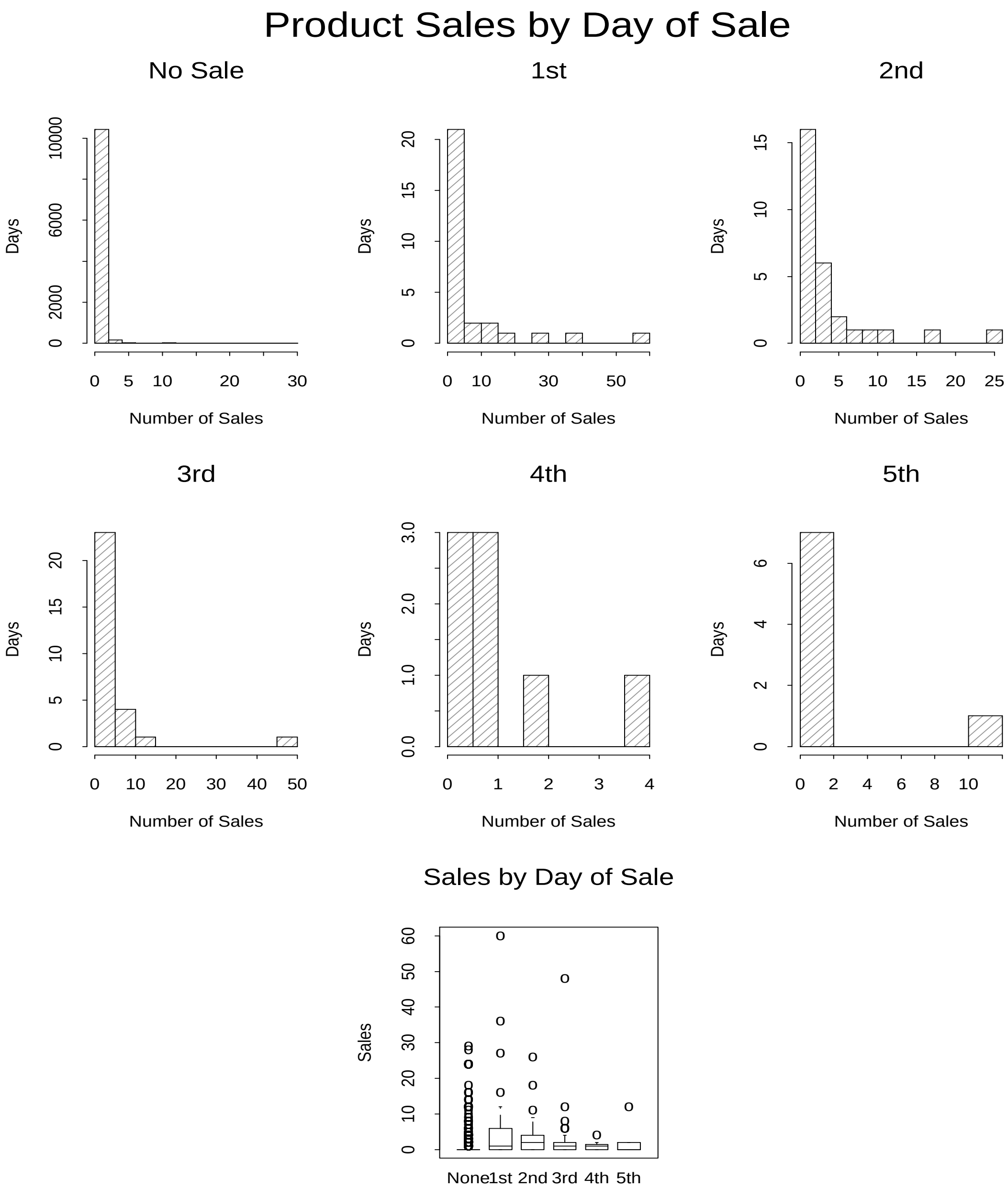

Figure 40: Product Sales by Day of Promotion

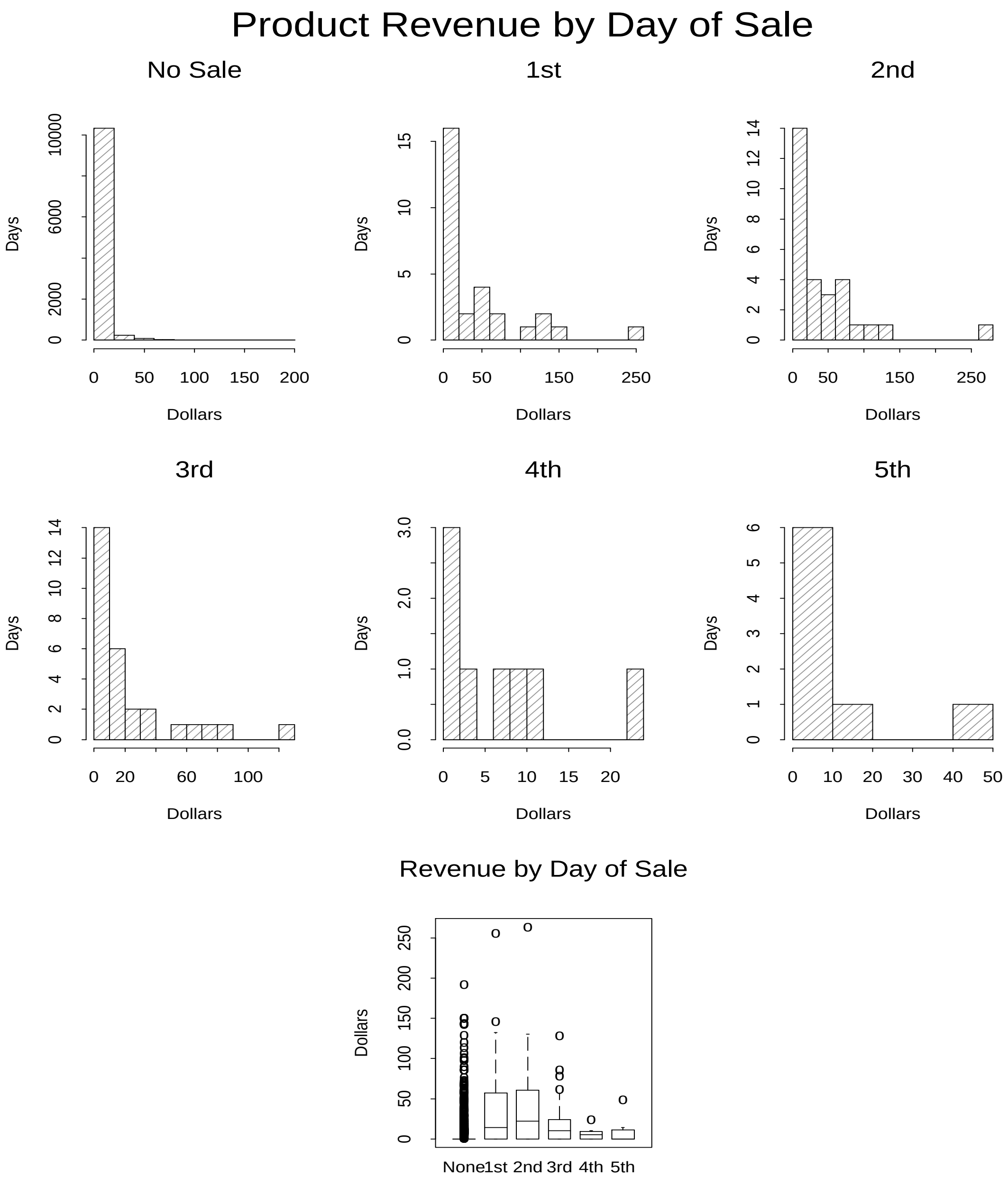

Figure 41: Product Revenue by Day of Promotion

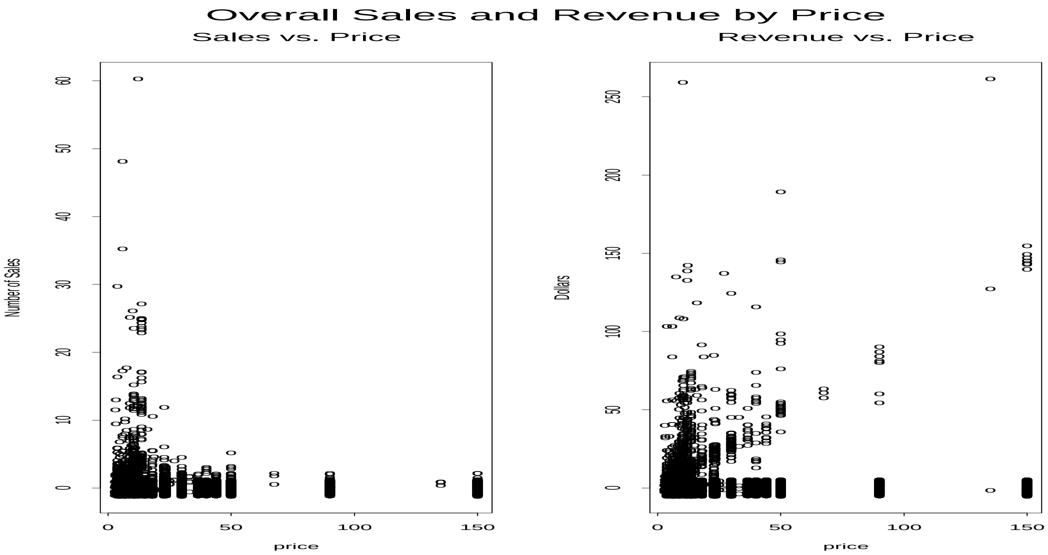

Figure 42: Product Sales and Revenue by Price

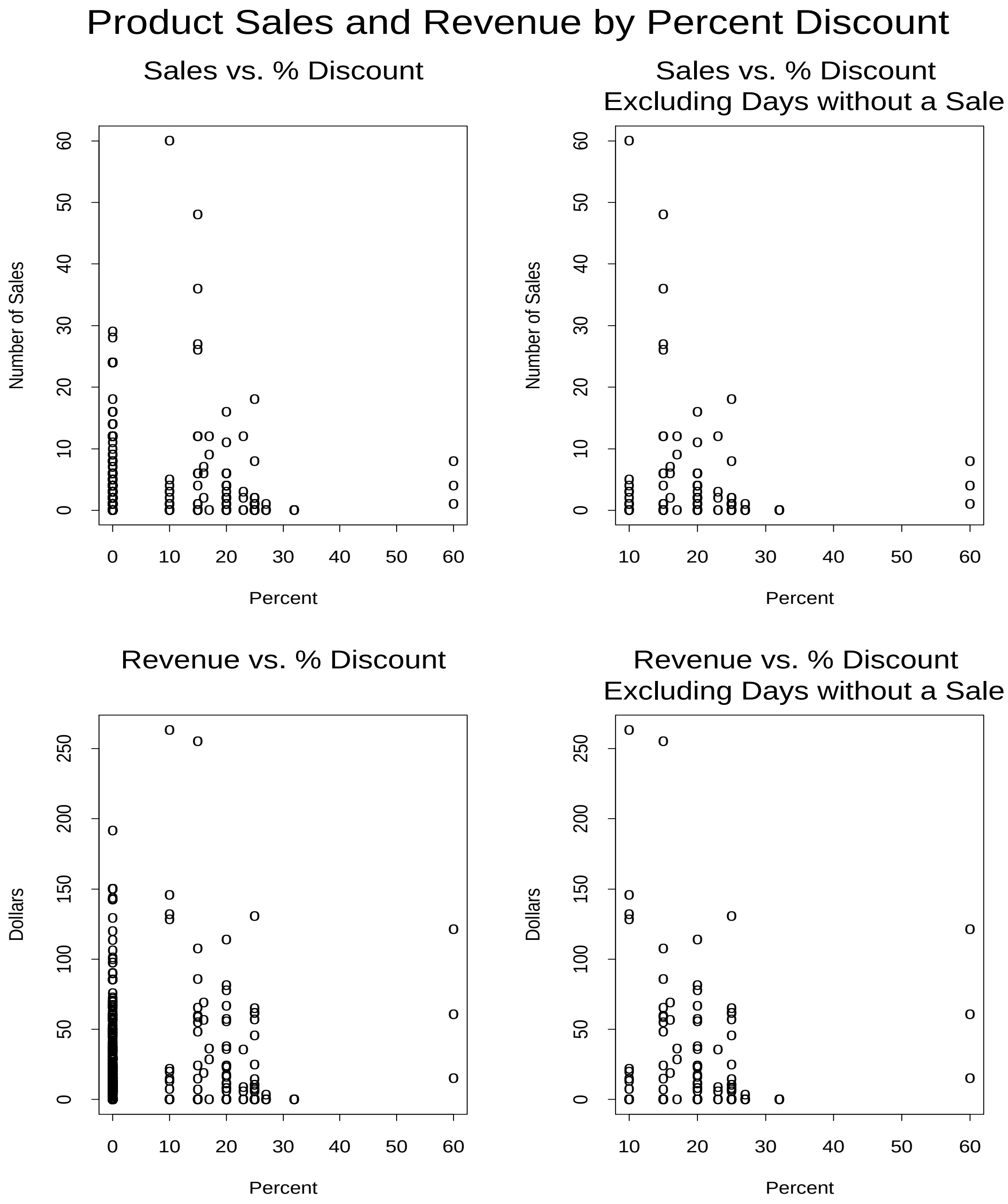

Figure 43: Product Sales and Revenue by Percent Discount

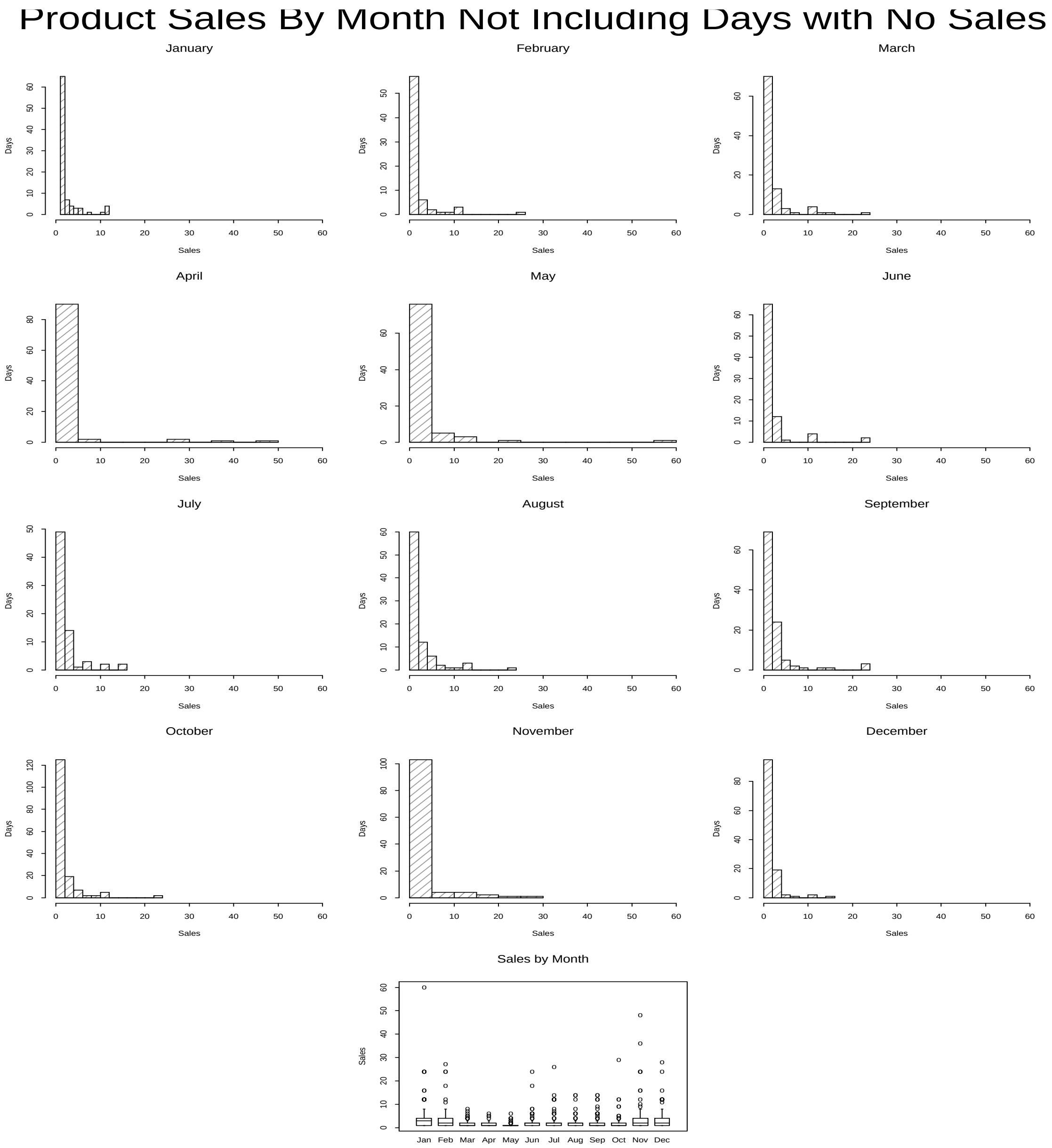

Figure 44: Product Sales By Month Not Including Days with No Sales

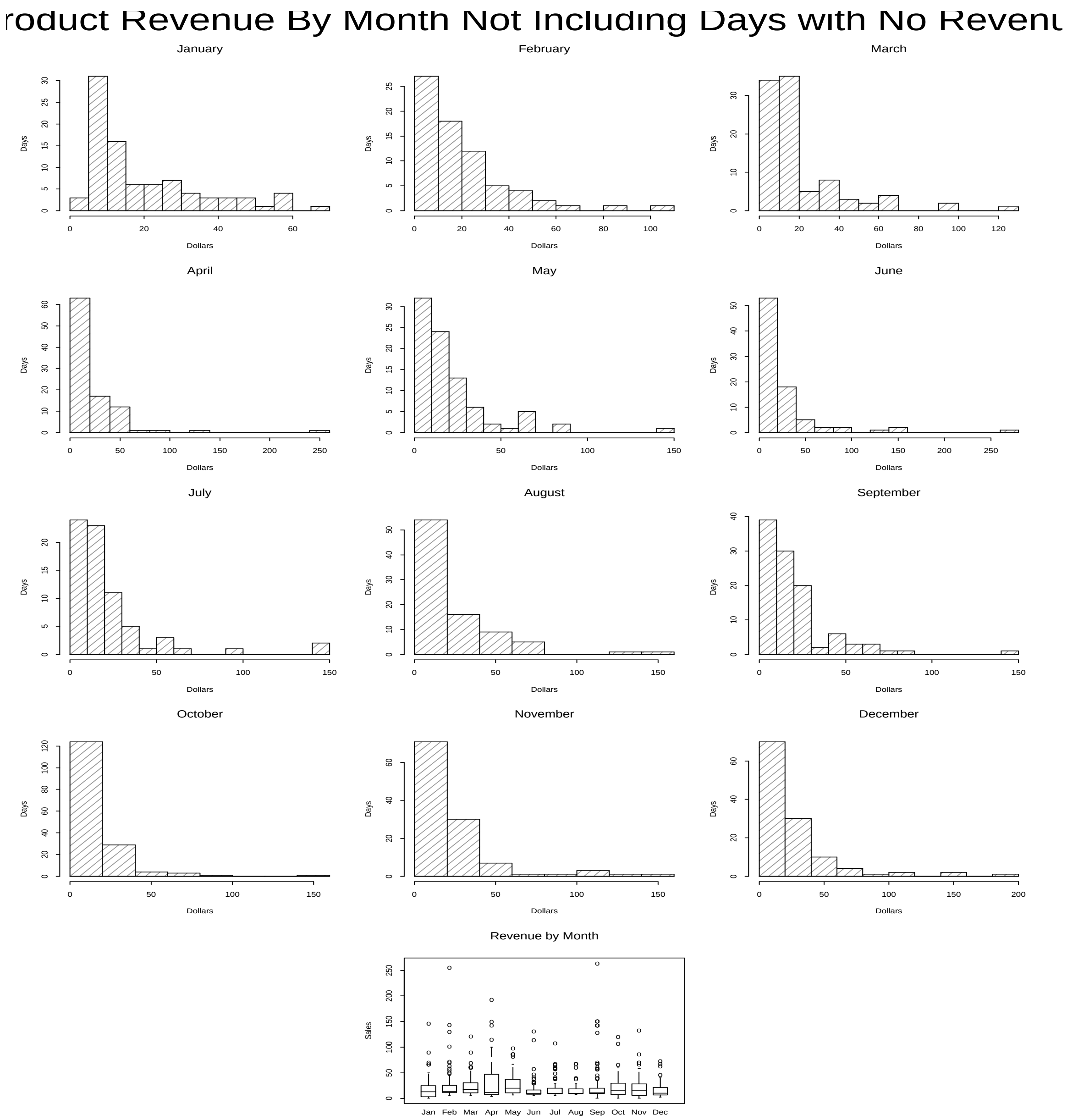

Figure 45: Product Revenue By Month Not Including Days with No Revenue

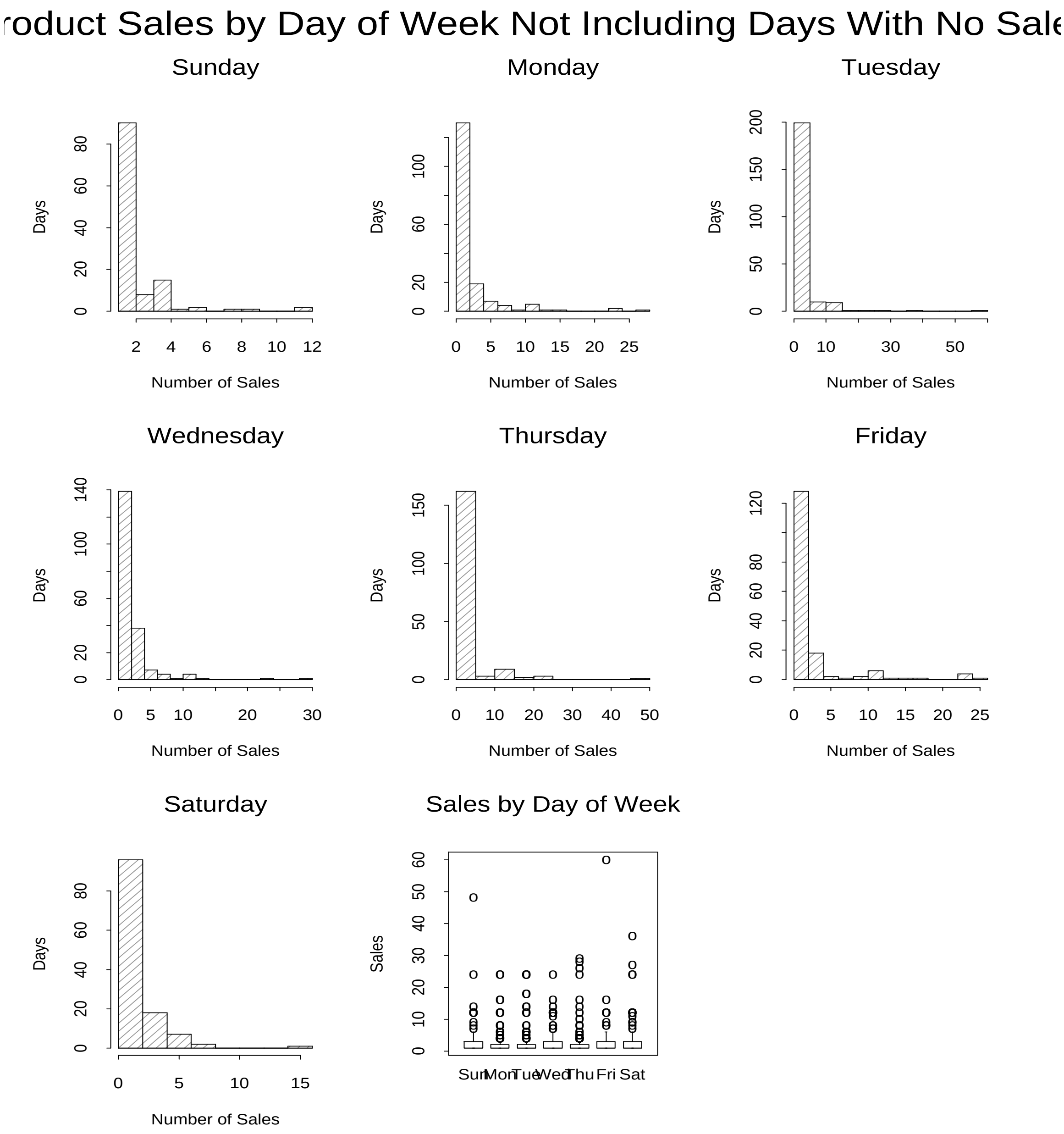

Figure 46: Product Sales by Day of the Week Not Including Days with No Sales

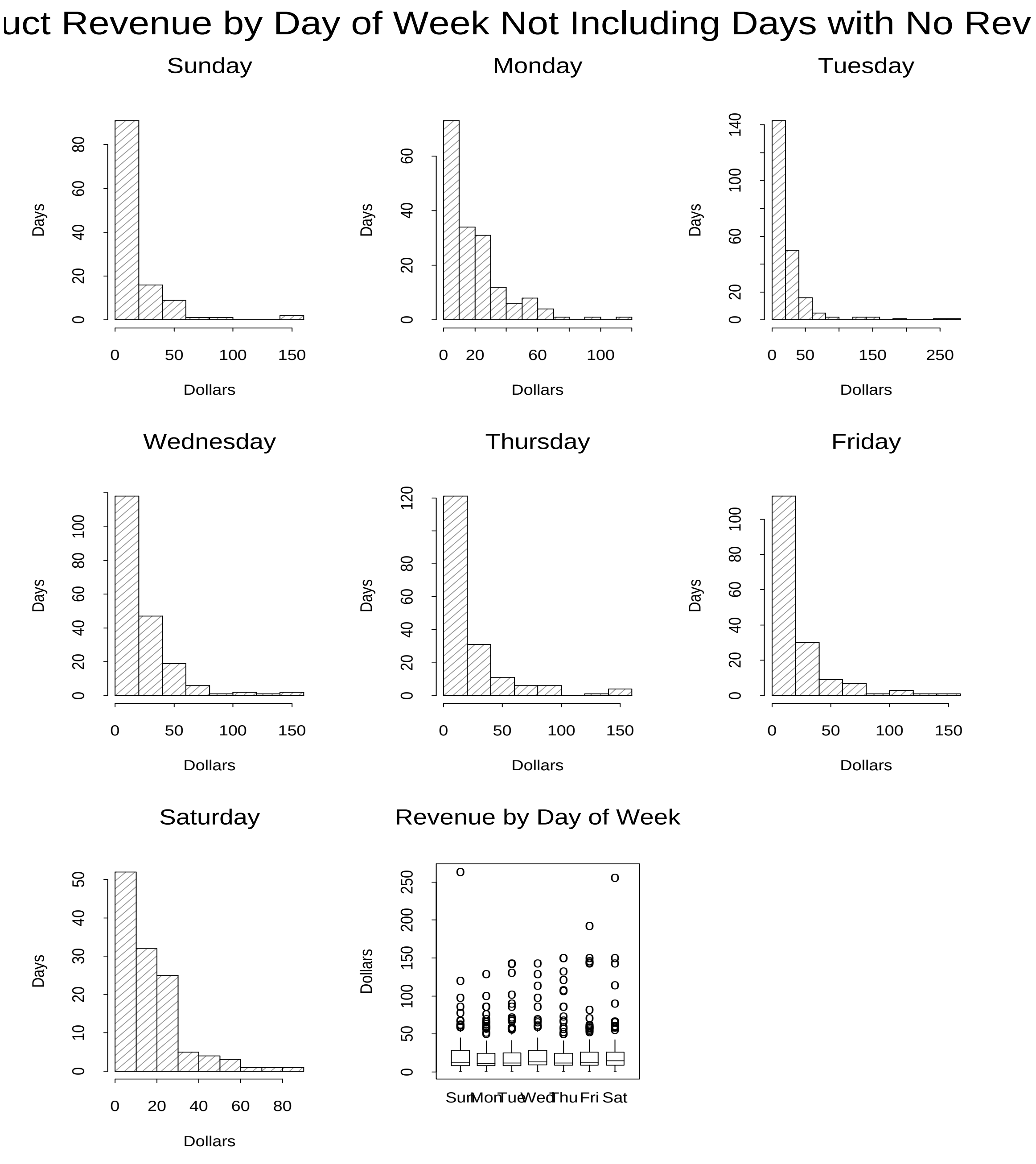

Figure 47: Product Revenue by Day of the Week Not Including Days with No Revenue

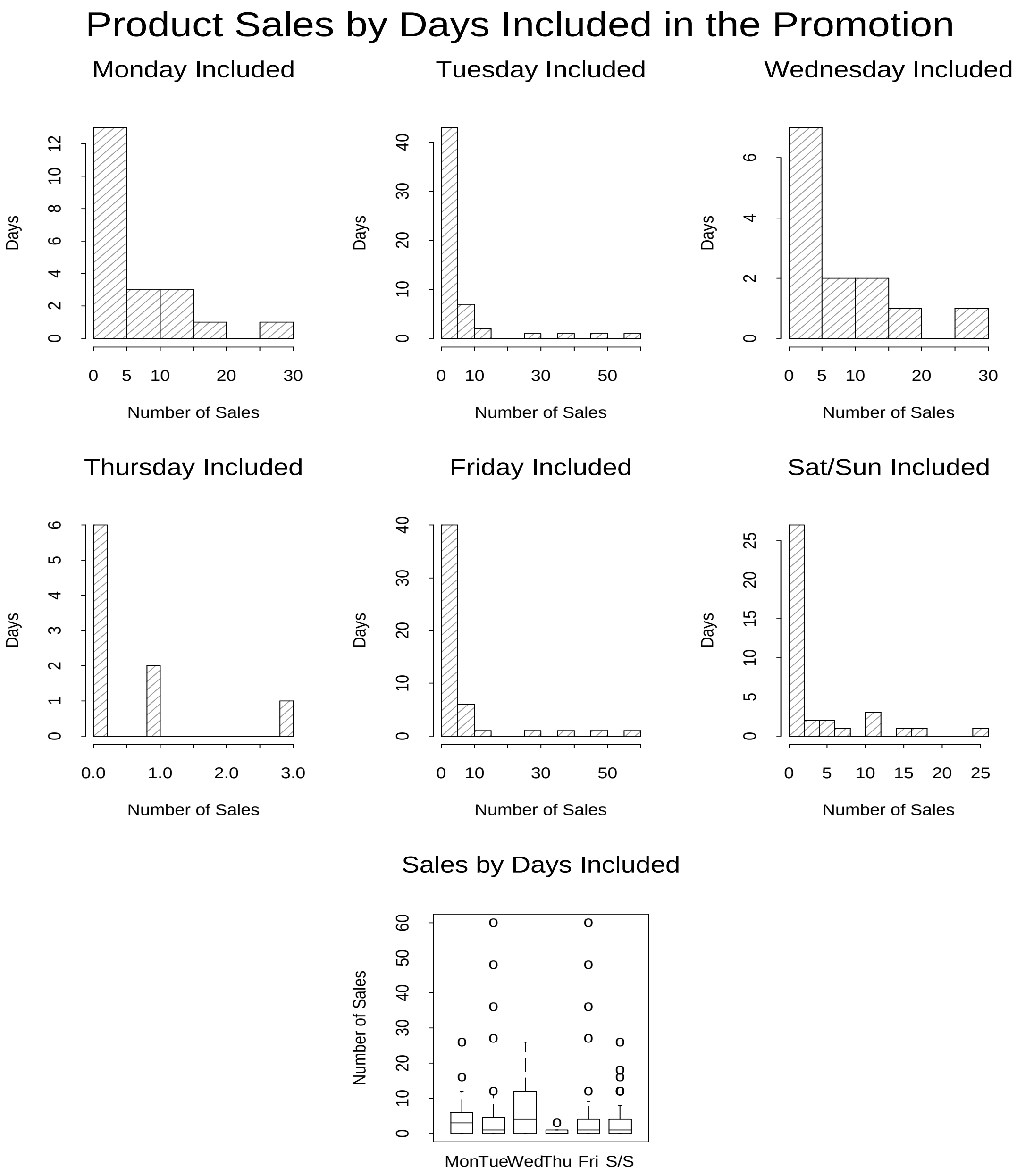

Figure 48: Product Sales by Days Included in the Promotion

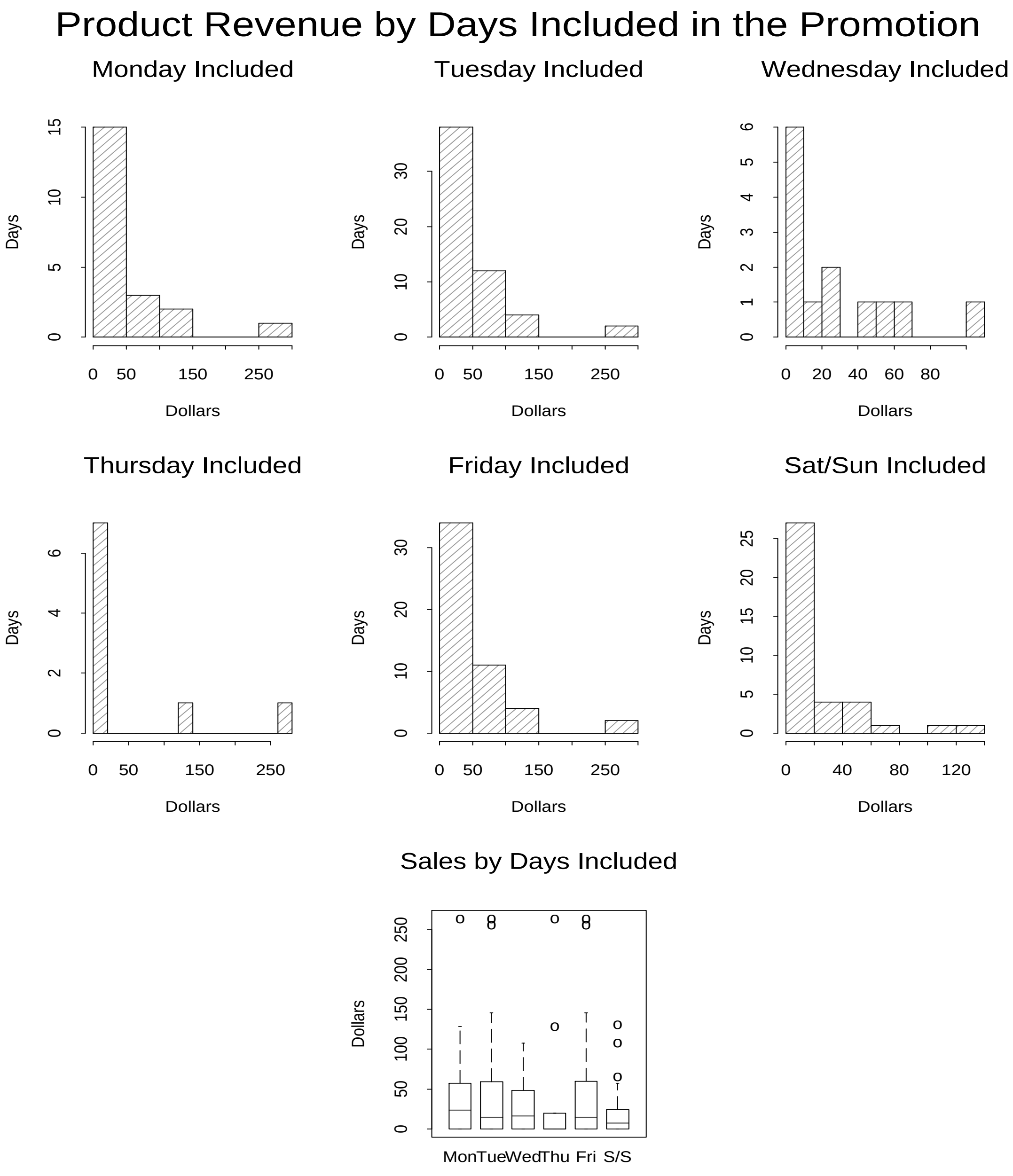

Figure 49: Product Revenue by Days Included in the Promotion

Appendix D
Regression Summaries and Diagnostic Plots

Summary and Diagnostics for The GLS Regression of Sales and Revenue on If There Is a Promotion

- Sales

```
Generalized least squares fit by REML
  Model: sales ~ is.sale
  Data: ellystats
       AIC      BIC    logLik
  3090.332 3106.426 -1541.166

Correlation Structure: AR(1)
 Parameter estimate(s):
      Phi
 0.496631

Coefficients:
               Value Std.Error  t-value p-value
(Intercept) 27.69682  1.032970 26.81281  <.0001
    is.sale  9.03717  1.439609  6.27752  <.0001

 Correlation:
        (Intr)
is.sale -0.338

Standardized residuals:
       Min         Q1         Med        Q3      Max
 -2.318486 -0.7552754 -0.06051503 0.6342453 3.149524

Residual standard error: 11.51476
Degrees of freedom: 415 total; 413 residual
```

- Revenue

```
Generalized least squares fit by REML
  Model: revenue ~ is.sale
  Data: ellystats
       AIC      BIC    logLik
  6452.851 6468.945 -3222.426

Correlation Structure: AR(1)
 Parameter estimate(s):
       Phi
 0.4078293

Coefficients:
               Value Std.Error  t-value p-value
(Intercept) 1379.748  52.42007 26.32098  <.0001
    is.sale  496.387  82.41372  6.02311  <.0001

 Correlation:
        (Intr)
is.sale -0.381

Standardized residuals:
       Min         Q1        Med        Q3      Max
 -2.168256 -0.6787649 -0.1410533 0.6025913 4.927752
```

```
Residual standard error: 641.301
Degrees of freedom: 415 total; 413 residual
```

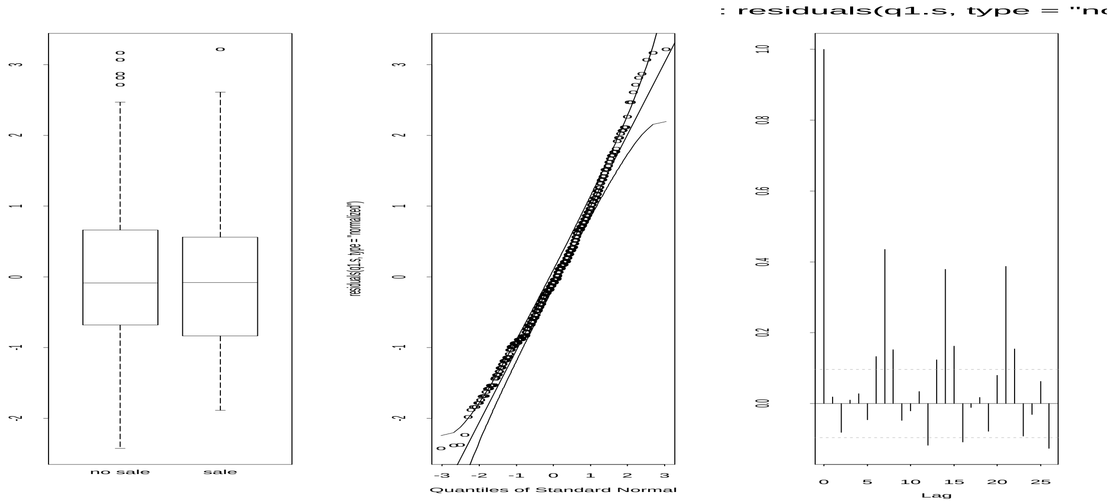

Figure 50: Diagnostic Plots for GLS Regression of Sales on Promotion

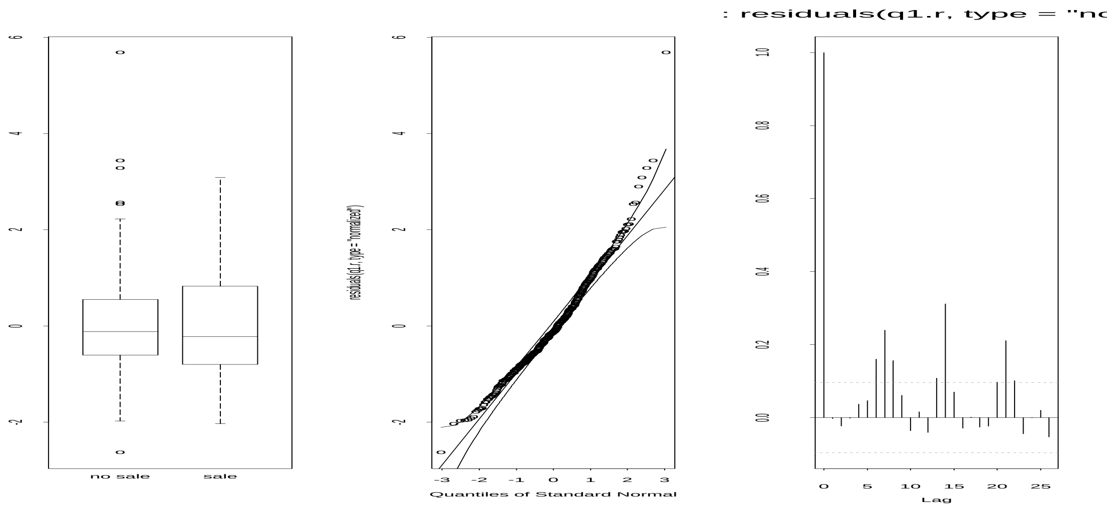

Figure 51: Diagnostic Plots for GLS Regression of Revenue on Promotion

Summary and Diagnostic Plots for the Final GLS Regression Models for Overall Sales and Revenue

- Sales

```
Generalized least squares fit by REML
  Model: finsalesform
  Data: sellystats[,  ]
       AIC      BIC    logLik
  947.4032 1054.489 -446.7016

Correlation Structure: AR(1)
 Parameter estimate(s):
       Phi
 0.3325988

Coefficients:
                Value Std.Error   t-value p-value
(Intercept)  4.642625  0.205634  22.57715  <.0001
    aveperc -2.159697  2.048642  -1.05421  0.2924
   highperc  1.298493  1.258318   1.03193  0.3027
     price5 -0.553861  0.276145  -2.00569  0.0456
        feb  0.087964  0.263994   0.33320  0.7392
        mar  0.656252  0.263684   2.48878  0.0132
        apr  0.598615  0.264850   2.26020  0.0244
        may  0.530824  0.274874   1.93116  0.0542
        jun  0.266250  0.266289   0.99985  0.3180
        jul -0.083294  0.266248  -0.31285  0.7546
        aug -0.588233  0.265671  -2.21414  0.0274
        sep -0.725913  0.228847  -3.17204  0.0016
        oct -0.944963  0.233816  -4.04149  0.0001
        nov -0.513273  0.263209  -1.95006  0.0519
        dec  0.313449  0.258701   1.21163  0.2264
      d.mon  1.210507  0.112406  10.76909  <.0001
      d.tue  1.278938  0.136383   9.37754  <.0001
      d.wed  0.910690  0.142822   6.37641  <.0001
      d.thu  0.870134  0.140666   6.18580  <.0001
      d.fri  0.691449  0.128689   5.37304  <.0001
      d.sat -0.229880  0.111346  -2.06456  0.0396
      dos.1  0.775743  0.178639   4.34251  <.0001
      dos.2  0.658222  0.159133   4.13631  <.0001
       xmas -3.305352  0.673255  -4.90951  <.0001
        thu  0.476080  0.283043   1.68201  0.0934

 Correlation:
        (Intr) aveprc hghprc price5    feb    mar    apr    may
 aveperc -0.113
highperc  0.140 -0.809
  price5  0.023  0.029 -0.229
     feb -0.620  0.068 -0.059  0.003
     mar -0.646  0.022 -0.086 -0.053  0.489
     apr -0.655  0.127 -0.132  0.023  0.481  0.506
     may -0.634  0.100 -0.127 -0.246  0.463  0.509  0.492
     jun -0.648  0.062 -0.102 -0.058  0.474  0.508  0.495  0.516
     jul -0.660  0.125 -0.200  0.054  0.479  0.507  0.506  0.491
     aug -0.651  0.138 -0.194  0.045  0.481  0.506  0.507  0.491
     sep -0.746  0.016 -0.072  0.015  0.548  0.580  0.569  0.554
     oct -0.722  0.076 -0.076  0.006  0.540  0.555  0.558  0.538
     nov -0.617 -0.063  0.043  0.020  0.471  0.485  0.477  0.459
     dec -0.632  0.034 -0.025  0.003  0.475  0.483  0.485  0.467
   d.mon -0.301  0.010 -0.003 -0.040  0.019  0.024  0.021  0.031
   d.tue -0.342  0.117 -0.132 -0.059  0.027  0.039  0.050  0.053
   d.wed -0.327  0.061 -0.068 -0.044  0.023  0.026  0.037  0.036
```

```
   d.thu -0.294  0.063 -0.060 -0.029  0.006 -0.019  0.014  0.007
   d.fri -0.299 -0.005  0.028  0.007 -0.001 -0.027  0.012 -0.010
   d.sat -0.273  0.010 -0.008  0.007  0.000 -0.019  0.021 -0.001
   dos.1  0.061 -0.097  0.063 -0.053 -0.014 -0.027 -0.034 -0.016
   dos.2  0.037 -0.066  0.036 -0.045 -0.012 -0.019 -0.029 -0.011
    xmas  0.004  0.014 -0.021  0.000  0.001  0.003  0.005  0.004
     thu -0.056 -0.455 -0.068  0.166 -0.026  0.106 -0.003  0.040
            jun    jul    aug    sep    oct    nov    dec  d.mon
 aveperc
highperc
  price5
     feb
     mar
     apr
     may
     jun
     jul  0.515
     aug  0.505  0.532
     sep  0.576  0.578  0.584
     oct  0.554  0.558  0.560  0.648
     nov  0.476  0.476  0.476  0.559  0.552
     dec  0.477  0.482  0.483  0.555  0.548  0.497
   d.mon  0.027  0.020  0.022  0.037  0.013  0.018  0.046
   d.tue  0.042  0.044  0.044  0.038  0.024  0.022  0.037  0.554
   d.wed  0.022  0.043  0.009  0.021  0.028  0.015  0.038  0.427
   d.thu -0.016  0.017 -0.017 -0.015  0.002 -0.005  0.032  0.384
   d.fri -0.030  0.006 -0.027 -0.012  0.000  0.003  0.005  0.383
   d.sat -0.019  0.020  0.002 -0.011  0.005  0.000  0.001  0.335
   dos.1 -0.062 -0.032 -0.041 -0.047 -0.031 -0.015  0.022 -0.049
   dos.2 -0.046 -0.026 -0.023 -0.031 -0.031 -0.020  0.022 -0.010
    xmas  0.004  0.006  0.004  0.002  0.003 -0.003 -0.082 -0.104
     thu  0.091  0.086  0.065  0.111 -0.002  0.022 -0.045  0.013
          d.tue  d.wed  d.thu  d.fri  d.sat  dos.1  dos.2   xmas
 aveperc
highperc
  price5
     feb
     mar
     apr
     may
     jun
     jul
     aug
     sep
     oct
     nov
     dec
   d.mon
   d.tue
   d.wed  0.646
   d.thu  0.496  0.655
   d.fri  0.431  0.494  0.625
   d.sat  0.375  0.392  0.437  0.578
   dos.1 -0.245 -0.129  0.096  0.040 -0.013
   dos.2 -0.121 -0.233 -0.003  0.016  0.010  0.539
    xmas  0.004  0.002 -0.003 -0.002  0.000 -0.018 -0.014
     thu  0.008 -0.049 -0.149 -0.069 -0.005 -0.211 -0.147  0.012

Standardized residuals:
       Min         Q1        Med        Q3      Max
 -3.670203 -0.5573744 0.06434007 0.6329508 2.378011

Residual standard error: 0.7411051
Degrees of freedom: 415 total; 390 residual
```

- Revenue

```
Generalized least squares fit by REML
  Model: newform
  Data: rellystats
       AIC      BIC    logLik
  2658.567 2815.857 -1289.284

Correlation Structure: AR(1)
 Parameter estimate(s):
       Phi
 0.3389055

Coefficients:
                Value Std.Error   t-value p-value
(Intercept)  32.34691   2.01255  16.07257  <.0001
   numprods  -0.60158   3.14092  -0.19153  0.8482
       body  -2.66255   2.73509  -0.97348  0.3309
       home   5.11529   2.79032   1.83323  0.0676
       food   0.05312   2.56973   0.02067  0.9835
    clothes  -0.84019   3.52523  -0.23834  0.8118
    aveperc -13.45730  36.35451  -0.37017  0.7115
   highperc  -6.94000  19.14501  -0.36250  0.7172
     price1  -1.70783   3.33486  -0.51211  0.6089
     price2  -3.25725   2.65408  -1.22726  0.2205
     price3   1.04834   3.40361   0.30801  0.7582
     price4  -6.27395   3.20991  -1.95456  0.0514
     price5  -6.55204   4.56241  -1.43609  0.1518
    is.sale  10.97840  13.78134   0.79661  0.4262
  start.tue   4.25213   7.58507   0.56059  0.5754
        tue  -2.70994   6.27507  -0.43186  0.6661
        wed   1.38287   5.22936   0.26444  0.7916
        thu   0.59420   7.31869   0.08119  0.9353
     length  -0.31531   1.47952  -0.21311  0.8314
        apr   3.45413   2.61217   1.32232  0.1869
        may   4.19365   2.70215   1.55196  0.1215
        dec   5.04442   2.57450   1.95938  0.0508
      d.mon   7.20139   1.05529   6.82406  <.0001
      d.tue   7.12332   1.31714   5.40817  <.0001
      d.wed   4.74027   1.36962   3.46102  0.0006
      d.thu   5.15088   1.34068   3.84199  0.0001
      dos.1   4.96910   1.70024   2.92259  0.0037
      dos.2   5.02506   1.50444   3.34016  0.0009
      d.fri   3.91827   1.22026   3.21101  0.0014
      d.sat  -1.83239   1.04277  -1.75723  0.0797
        feb   0.22900   2.68411   0.08532  0.9321
        mar   4.46127   2.61346   1.70704  0.0886
        jun   3.85917   2.61435   1.47615  0.1407
        jul   0.37869   2.59444   0.14596  0.8840
        aug   0.65399   2.59437   0.25208  0.8011
        sep  -3.47638   2.26717  -1.53335  0.1260
        oct  -4.96175   2.32585  -2.13331  0.0335
        nov  -2.64602   2.77865  -0.95227  0.3416

 Correlation:
         (Intr) nmprds   body   home   food cloths aveprc hghprc
 numprods  0.025
     body -0.047 -0.348
     home  0.019 -0.252  0.159
     food  0.005 -0.457  0.432  0.095
  clothes  0.011  0.082 -0.151 -0.256 -0.023
  aveperc -0.031  0.191  0.012  0.254 -0.129 -0.240
 highperc  0.023 -0.043  0.137 -0.267  0.107  0.238 -0.870
   price1 -0.065 -0.487  0.241  0.112  0.314 -0.178  0.204 -0.250
```

price2	-0.051	0.104	0.094	-0.022	0.242	-0.070	0.112	0.057
price3	-0.036	-0.229	0.282	0.228	0.098	-0.409	0.480	-0.414
price4	-0.028	-0.095	0.128	-0.300	0.147	0.271	-0.424	0.410
price5	-0.038	-0.599	0.529	-0.017	0.490	-0.123	-0.004	-0.072
is.sale	0.061	-0.550	-0.212	0.139	0.090	0.019	-0.349	0.128
start.tue	0.155	-0.178	-0.238	-0.096	-0.194	-0.207	0.331	-0.481
tue	-0.149	0.047	0.234	0.036	0.289	0.150	-0.277	0.356
wed	0.044	0.578	-0.322	-0.353	-0.507	0.117	0.069	-0.003
thu	-0.164	-0.335	0.420	0.097	0.300	0.080	-0.295	0.246
length	0.036	0.260	-0.004	-0.237	-0.099	-0.021	0.155	-0.131
apr	-0.671	-0.020	0.089	-0.076	0.007	0.063	-0.010	0.045
may	-0.641	0.074	0.004	0.012	-0.049	-0.045	-0.008	0.015
dec	-0.629	0.043	-0.056	-0.120	-0.027	0.034	0.019	0.003
d.mon	-0.270	0.021	-0.041	-0.029	0.002	0.016	0.037	-0.033
d.tue	-0.325	0.006	-0.013	-0.017	0.004	0.009	0.012	-0.014
d.wed	-0.315	0.012	-0.011	-0.017	0.005	0.007	0.012	-0.010
d.thu	-0.281	0.026	-0.016	-0.016	0.003	0.007	0.019	-0.014
dos.1	0.054	0.021	-0.016	-0.009	0.000	0.003	0.014	-0.008
dos.2	0.034	0.017	-0.017	-0.008	0.000	0.004	0.012	-0.009
d.fri	-0.282	0.018	-0.008	-0.008	0.002	0.003	0.014	-0.007
d.sat	-0.261	0.002	0.006	-0.003	0.000	0.000	0.002	0.001
feb	-0.615	-0.006	0.087	0.091	-0.031	-0.041	0.144	-0.098
mar	-0.659	-0.047	0.038	-0.035	0.063	0.007	-0.038	0.011
jun	-0.653	-0.056	-0.014	-0.064	-0.064	0.037	0.041	-0.054
jul	-0.675	-0.082	0.072	-0.033	0.020	0.007	0.035	-0.070
aug	-0.658	-0.013	0.023	-0.016	-0.018	-0.054	0.024	-0.050
sep	-0.756	-0.071	0.053	0.067	0.025	-0.009	0.013	-0.016
oct	-0.732	0.025	0.066	-0.012	-0.003	-0.079	0.067	-0.015
nov	-0.598	-0.141	0.140	0.032	-0.025	-0.033	-0.091	0.089

	price1	price2	price3	price4	price5	is.sal	strt.t	tue
numprods								
body								
home								
food								
clothes								
aveperc								
highperc								
price1								
price2	0.164							
price3	0.587	0.237						
price4	0.126	0.415	-0.163					
price5	0.581	-0.002	0.308	0.154				
is.sale	0.163	-0.075	-0.015	0.102	0.036			
start.tue	0.281	-0.306	0.389	-0.325	0.100	0.260		
tue	-0.245	0.223	-0.389	0.284	-0.019	-0.302	-0.888	
wed	-0.491	-0.198	-0.299	-0.205	-0.405	-0.502	0.071	-0.152
thu	0.018	-0.123	-0.269	0.164	0.378	-0.236	-0.599	0.695
length	-0.164	-0.238	0.069	-0.177	0.020	-0.641	0.286	-0.137
apr	0.024	0.058	-0.029	0.108	0.080	-0.078	-0.197	0.173
may	-0.038	0.077	-0.044	0.004	-0.200	-0.028	-0.198	0.163
dec	-0.006	0.066	-0.053	0.009	-0.031	-0.050	-0.132	0.168
d.mon	0.003	0.007	-0.004	0.000	-0.020	-0.024	0.066	-0.072
d.tue	0.002	0.005	-0.002	0.009	-0.006	-0.001	0.002	-0.065
d.wed	0.003	0.017	0.005	0.016	-0.004	-0.022	0.004	-0.016
d.thu	-0.003	0.020	-0.002	0.013	-0.008	-0.048	0.005	-0.014
dos.1	-0.004	0.012	-0.005	0.001	-0.007	-0.104	0.005	0.017
dos.2	-0.003	0.006	-0.008	-0.002	-0.007	-0.081	0.005	0.001
d.fri	-0.002	0.018	0.001	0.011	-0.003	-0.051	0.014	0.033
d.sat	-0.005	0.005	-0.002	0.006	0.003	-0.003	-0.005	0.004
feb	0.158	-0.003	0.097	-0.096	0.068	-0.141	-0.100	0.075
mar	0.161	0.050	0.089	0.036	0.056	0.001	-0.116	0.095
jun	0.035	-0.049	0.043	-0.008	0.023	-0.050	-0.034	0.052
jul	0.095	0.035	0.083	0.063	0.121	-0.021	-0.095	0.097
aug	-0.034	-0.042	-0.072	-0.051	0.042	-0.052	-0.135	0.139

```
       sep  0.104  0.050  0.033  0.045  0.086 -0.041 -0.173  0.166
       oct  0.047  0.147  0.114  0.056  0.037 -0.125 -0.160  0.163
       nov  0.027 -0.028  0.032  0.000  0.056  0.133 -0.159  0.193
              wed    thu length    apr    may    dec  d.mon  d.tue
  numprods
      body
      home
      food
   clothes
   aveperc
  highperc
    price1
    price2
    price3
    price4
    price5
   is.sale
 start.tue
       tue
       wed
       thu -0.198
    length  0.429 -0.084
       apr -0.020  0.183 -0.040
       may  0.007  0.088 -0.097  0.498
       dec  0.054  0.088 -0.105  0.490  0.475
     d.mon  0.045 -0.042  0.055  0.007  0.008  0.021
     d.tue -0.004 -0.016  0.065  0.058  0.047 -0.004  0.550
     d.wed -0.052 -0.023  0.089  0.043  0.030  0.006  0.425  0.655
     d.thu -0.001 -0.068  0.108  0.017  0.002  0.004  0.385  0.507
     dos.1  0.024 -0.027  0.087 -0.024 -0.030  0.021 -0.038 -0.227
     dos.2  0.038 -0.018  0.063 -0.021 -0.022  0.020  0.000 -0.108
     d.fri -0.009 -0.030  0.088  0.004 -0.015  0.001  0.376  0.408
     d.sat  0.002 -0.001  0.001  0.021  0.000  0.000  0.331  0.362
       feb  0.057  0.122 -0.052  0.474  0.458  0.472  0.005  0.007
       mar -0.085  0.121 -0.066  0.518  0.512  0.480  0.007  0.046
       jun  0.013  0.152  0.025  0.509  0.491  0.479  0.021  0.044
       jul -0.068  0.154 -0.033  0.527  0.487  0.481  0.006  0.045
       aug  0.018  0.183 -0.029  0.517  0.503  0.490  0.007  0.044
       sep -0.104  0.235 -0.101  0.586  0.552  0.551  0.019  0.036
       oct -0.046  0.111  0.010  0.571  0.544  0.541 -0.003  0.026
       nov -0.185  0.191 -0.257  0.468  0.458  0.498 -0.033 -0.029
            d.wed  d.thu  dos.1  dos.2  d.fri  d.sat    feb    mar
  numprods
      body
      home
      food
   clothes
   aveperc
  highperc
    price1
    price2
    price3
    price4
    price5
   is.sale
 start.tue
       tue
       wed
       thu
    length
       apr
       may
       dec
     d.mon
```

```
    d.tue
    d.wed
    d.thu  0.666
    dos.1 -0.110  0.105
    dos.2 -0.217  0.006  0.550
    d.fri  0.489  0.622  0.048  0.018
    d.sat  0.382  0.431 -0.013  0.009  0.574
      feb -0.005 -0.012 -0.010 -0.005 -0.013 -0.001
      mar  0.029 -0.016 -0.037 -0.027 -0.032 -0.019  0.496
      jun  0.027 -0.014 -0.041 -0.030 -0.032 -0.020  0.465  0.504
      jul  0.045  0.016 -0.029 -0.024  0.002  0.020  0.476  0.526
      aug  0.009 -0.019 -0.034 -0.018 -0.033  0.002  0.476  0.499
      sep  0.022 -0.018 -0.031 -0.020 -0.018 -0.011  0.556  0.587
      oct  0.039  0.011 -0.016 -0.023  0.007  0.006  0.525  0.560
      nov -0.017 -0.048 -0.044 -0.048 -0.011  0.000  0.438  0.467
             jun    jul    aug    sep    oct
 numprods
     body
     home
     food
  clothes
  aveperc
 highperc
   price1
   price2
   price3
   price4
   price5
  is.sale
start.tue
      tue
      wed
      thu
   length
      apr
      may
      dec
    d.mon
    d.tue
    d.wed
    d.thu
    dos.1
    dos.2
    d.fri
    d.sat
      feb
      mar
      jun
      jul  0.532
      aug  0.509  0.531
      sep  0.582  0.592  0.588
      oct  0.553  0.573  0.554  0.653
      nov  0.457  0.474  0.469  0.547  0.523

Standardized residuals:
       Min         Q1          Med        Q3      Max
 -5.115016 -0.5409164 0.0005121614 0.5758953 3.897419

Residual standard error: 6.972982
Degrees of freedom: 415 total; 377 residual
```

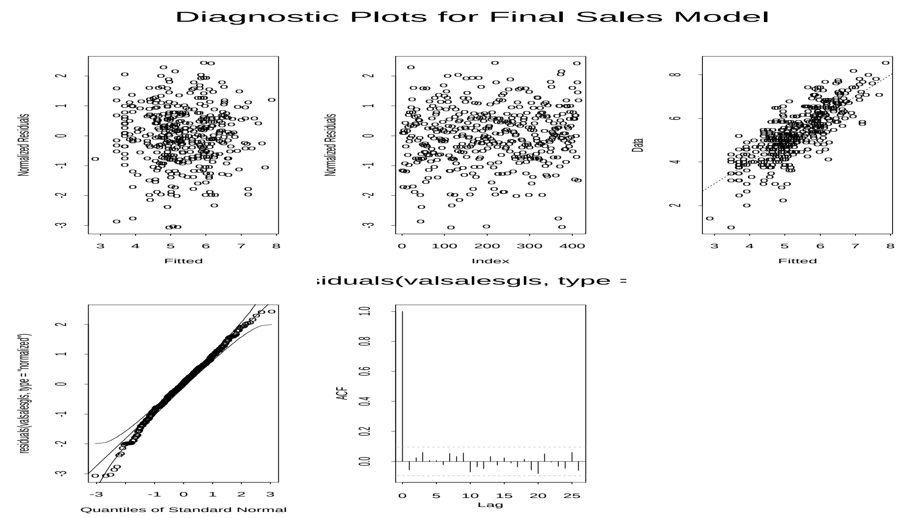

Figure 52: Diagnostic Plots for Regression of Sales on Selected Variables

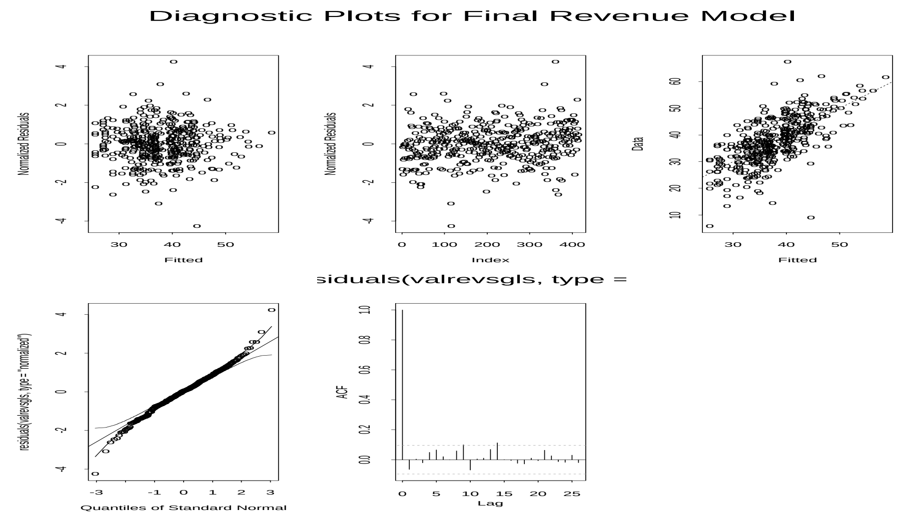

Figure 53: Diagnostic Plots for Regression of Revenue on Selected Variables

Appendix E
The Model Selection Process

The process used to select the final modes was a forwards/backwards step method using the Akaike information criterion (AIC) as a measure of model fit. Particularly, the AIC presented in the tables below were calculated using:

$$-2(log - likelihood) + 2(numberofparameters)$$

Thus, the model with the largest likelihood (as penalized by the number of parameters included in the model) has the smallest AIC.

The initial determinants were chosen on the basis of having at least 0.1 correlation with overall sales and revenue. For the sales prediction model, both forwards and backwards steps were used to find the best model. However, the backwards method for revenue removed only one determinant, so in the interest of keeping a simple model, the forwards process was not used (although it is presented in the table below, and its validation data is presented at the end of this Appendix).

SALES	
AIC	**Model**
1076.755	flyers + numprods + body + home + cleaning + food + clothes + aveperc + highperc + price1 + price2 + price3 + price4 + price5 + is.sale + start.tue + tue + wed + thu + length + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2
BACKWARD SELECTION	
1058.186	numprods + body + home + cleaning + food + clothes + aveperc + highperc + price1 + price2 + price3 + price4 + price5 + is.sale + start.tue + tue + wed + thu + length + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2
1055.812	numprods + body + home + cleaning + clothes + aveperc + highperc + price1 + price2 + price3 + price4 + price5 + is.sale + start.tue + tue + wed + thu + length + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2
1053.460	numprods + body + home + cleaning + clothes + aveperc + highperc + price1 + price2 + price3 + price4 + price5 + is.sale + start.tue + tue + wed + thu + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2
1051.480	numprods + home + cleaning + clothes + aveperc + highperc + price1 + price2 + price3 + price4 + price5 + is.sale + start.tue + tue + wed + thu + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2
1049.642	numprods + home + cleaning + clothes + aveperc + highperc + price2 + price3 + price4 + price5 + is.sale + start.tue + tue + wed + thu + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2
1048.193	numprods + home + cleaning + clothes + aveperc + highperc + price3 + price4 + price5 + is.sale + start.tue + tue + wed + thu + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2

SALES,*continued*	
AIC	**Model**
1046.247	home + cleaning + clothes + aveperc+highperc + price3 + price4 + price5 + is.sale + start.tue + tue + wed + thu + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2
1044.754	home + cleaning + clothes + aveperc + highperc + price3 + price4 + price5 + is.sale + start.tue + tue + thu + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2
1043.410	home + clothes + aveperc + highperc + price3 + price4 + price5 + is.sale + start.tue + tue + thu + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2
1042.481	home + clothes + aveperc + highperc + price3 + price4 + price5 + is.sale + tue + thu + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2
1041.496	home + clothes + aveperc + highperc + price3 + price4 + price5 + tue + thu + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2
1040.390	home + clothes + aveperc + highperc + price3 + price4 + price5 + tue + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2
1039.709	home + aveperc + highperc + price3 + price4 + price5 + tue + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2
1038.810	home + aveperc + highperc + price3 + price5 + tue + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2
1038.369	aveperc + highperc + price3 + price5 + tue + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2
1036.939	aveperc + highperc + price3 + price5 + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2
1036.591	aveperc + highperc + price5 + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2
FORWARD SELECTION	
982.320	aveperc + highperc + price5 + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2 + d.fri
967.440	aveperc + highperc + price5 + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2 + d.fri + xmas
960.610	aveperc + highperc + price5 + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2 + d.fri + xmas + oct
949.138	aveperc + highperc + price5 + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2 + d.fri + xmas + oct + sep
943.982	aveperc + highperc + price5 + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2 + d.fri + xmas + oct + sep + aug
938.341	aveperc + highperc + price5 + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2 + d.fri + xmas + oct + sep + aug + nov
937.880	aveperc + highperc + price5 + mar + apr + may + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2 + d.fri + xmas + oct + sep + aug + nov + thu

REVENUE	
AIC	**Model**
2738.294	flyers + numprods + body + home + food + clothes + aveperc + highperc + price1 + price2 + price3 + price4 + price5 + is.sale + start.tue + tue + wed + thu + length + apr + may + dec + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2
BACKWARD SELECTION	
2724.790	numprods + body + home + food + clothes + aveperc + highperc + price1 + price2 + price3 + price4 + price5 + is.sale + start.tue + tue + wed + thu + length + apr + may + dec + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2
All Days and Months Added	
FORWARD SELECTION	
2658.567	numprods + body + home + food + clothes + aveperc + highperc + price1 + price2 + price3 + price4 + price5 + is.sale + start.tue + tue + wed + thu + length + apr + may + dec + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2 + d.fri + d.sat + feb + mar + jun + jul + aug + sep + oct + nov
2650.373	numprods + body + home + food + clothes + aveperc + highperc + price1 + price2 + price3 + price4 + price5 + is.sale + start.tue + tue + wed + thu + length + apr + may + dec + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2 + d.fri + d.sat + feb + mar + jun + jul + aug + sep + oct + nov + sat.sun
2645.179	numprods + body + home + food + clothes + aveperc + highperc + price1 + price2 + price3 + price4 + price5 + is.sale + start.tue + tue + wed + thu + length + apr + may + dec + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2 + d.fri + d.sat + feb + mar + jun + jul + aug + sep + oct + nov + sat.sun + dos.6
2640.379	numprods + body + home + food + clothes + aveperc + highperc + price1 + price2 + price3 + price4 + price5 + is.sale + start.tue + tue + wed + thu + length + apr + may + dec + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2 + d.fri + d.sat + feb + mar + jun + jul + aug + sep + oct + nov + sat.sun + dos.6 + start.sat
2620.08	numprods + body + home + food + clothes + aveperc + highperc + price1 + price2 + price3 + price4 + price5 + is.sale + start.tue + tue + wed + thu + length + apr + may + dec + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2 + d.fri + d.sat + feb + mar + jun + jul + aug + sep + oct + nov + sat.sun + dos.6 + start.sat + xmas
2615.69	numprods + body + home + food + clothes + aveperc + highperc + price1 + price2 + price3 + price4 + price5 + is.sale + start.tue + tue + wed + thu + length + apr + may + dec + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2 + d.fri + d.sat + feb + mar + jun + jul + aug + sep + oct + nov + sat.sun + dos.6 + start.sat + xmas + cleaning
2612.726	numprods + body + home + food + clothes + aveperc + highperc + price1 + price2 + price3 + price4 + price5 + is.sale + start.tue + tue + wed + thu + length + apr + may + dec + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2 + d.fri + d.sat + feb + mar + jun + jul + aug + sep + oct + nov + sat.sun + dos.6 + start.sat + xmas + cleaning + dos.5
2610.785	numprods + body + home + food + clothes + aveperc + highperc + price1 + price2 + price3 + price4 + price5 + is.sale + start.tue + tue + wed + thu + length + apr + may + dec + d.mon + d.tue + d.wed + d.thu + dos.1 + dos.2 + d.fri + d.sat + feb + mar + jun + jul + aug + sep + oct + nov + sat.sun + dos.6 + start.sat + xmas + cleaning + dos.5 + dos.3
Singular fits: +start.mon, +start.wed, +start.thu, +mon, +fri, +dos.4. Therefore, dos.4 replaced is.sale, and the others are left out.	

REVENUE PREDICTIONS–forward selection model						
Date	Prediction	Lowest Error	Highest Error	True Value	Correct Prediction	Difference
9/5/01	37.02215	24.8319655	49.21234	50.62934	F	-13.607188
9/6/01	38.53679	26.3466064	50.72698	33.93184	T	4.604949
9/7/01	30.68114	18.4909580	42.87133	46.04563	F	-15.364486
9/18/01	19.21817	6.8087652	31.62758	46.41077	F	-27.192601
9/19/01	16.80153	4.3921237	29.21094	46.07114	F	-29.269608
9/20/01	12.21636	-0.1930513	24.62577	36.48767	F	-24.271312
10/2/01	38.30832	25.5879879	51.02865	51.69042	F	-13.382108
10/3/01	35.19260	22.4722759	47.91293	41.25458	T	-6.061971
10/4/01	30.93362	18.2132863	43.65394	45.89989	F	-14.966276
10/16/01	39.78964	26.9613398	52.61794	50.57994	T	-10.790298
10/17/01	36.94859	24.1202912	49.77689	62.04982	F	-25.101229
10/18/01	32.35930	19.5310045	45.18760	52.28642	F	-19.927119
average difference: -16.27744						
t-statistic for testing if this is different than zero: -0.1735632						
p-value: 0.8653615						

Appendix F
The Analysis of Revenue Outliers

As seen in the diagnostic plots for the final revenue model, there are two distinct outliers. One is observation number 116 (Christmas Day 2000), and observation number 361 (August 27, 2001–a Monday that does not seem to have any notable characteristic) Removal of these observations yields the diagnostic plots in Figure **??** and summary below. However removing the outliers only slightly affected the coefficient values, and only changed price4's significance to the model. In addition, the removal does not improve the prediction validity for the regression model; prediction data is presented after the model summary.

```
Generalized least squares fit by REML
  Model: newform
  Data: rellystats[ - c(116, 361),  ]
       AIC      BIC    logLik
  2604.321 2761.399 -1262.161

Correlation Structure: AR(1)
 Parameter estimate(s):
       Phi
 0.3237973

Coefficients:
                Value Std.Error   t-value p-value
(Intercept)  32.42763   1.87265  17.31648  <.0001
   numprods  -0.44632   2.94822  -0.15139  0.8798
       body  -2.91997   2.56683  -1.13758  0.2560
       home   4.90553   2.62278   1.87035  0.0622
       food   0.00465   2.41330   0.00193  0.9985
    clothes  -0.50351   3.31081  -0.15208  0.8792
    aveperc -14.39064  34.10724  -0.42192  0.6733
   highperc  -6.05818  17.96919  -0.33714  0.7362
     price1  -1.81419   3.13438  -0.57880  0.5631
     price2  -3.10990   2.49304  -1.24743  0.2130
     price3   0.88352   3.20008   0.27609  0.7826
     price4  -6.17035   3.01578  -2.04602  0.0415
     price5  -6.95408   4.28465  -1.62302  0.1054
    is.sale  11.13708  12.93187   0.86121  0.3897
  start.tue   4.07850   7.12017   0.57281  0.5671
        tue  -2.39850   5.88771  -0.40737  0.6840
        wed   1.66173   4.90895   0.33851  0.7352
        thu   0.24315   6.86350   0.03543  0.9718
     length  -0.41982   1.38820  -0.30242  0.7625
        apr   3.42139   2.42412   1.41140  0.1590
        may   4.16912   2.50766   1.66255  0.0972
        dec   6.27582   2.41493   2.59877  0.0097
      d.mon   7.10945   1.01296   7.01849  <.0001
      d.tue   7.11224   1.23765   5.74658  <.0001
      d.wed   4.72119   1.28899   3.66271  0.0003
      d.thu   5.13645   1.26347   4.06535  0.0001
      dos.1   4.98701   1.61331   3.09117  0.0021
      dos.2   5.04633   1.43115   3.52607  0.0005
      d.fri   3.89928   1.15409   3.37867  0.0008
      d.sat  -1.86995   0.99166  -1.88569  0.0601
        feb   0.25387   2.49665   0.10169  0.9191
        mar   4.38716   2.42659   1.80795  0.0714
        jun   3.79533   2.42646   1.56414  0.1186
        jul   0.29415   2.40825   0.12214  0.9029
        aug  -0.33552   2.42885  -0.13814  0.8902
        sep  -3.53167   2.10433  -1.67829  0.0941
        oct  -5.03373   2.15896  -2.33155  0.0203
        nov  -2.55160   2.58131  -0.98849  0.3236
```

```
Correlation:
         (Intr) nmprds   body   home   food cloths aveprc hghprc
numprods  0.025
    body -0.048 -0.348
    home  0.019 -0.253  0.160
    food  0.006 -0.457  0.433  0.096
 clothes  0.011  0.082 -0.151 -0.256 -0.023
 aveperc -0.032  0.190  0.013  0.256 -0.130 -0.241
highperc  0.024 -0.041  0.137 -0.269  0.108  0.239 -0.870
  price1 -0.066 -0.488  0.241  0.114  0.314 -0.178  0.202 -0.249
  price2 -0.052  0.104  0.096 -0.022  0.242 -0.070  0.112  0.058
  price3 -0.037 -0.230  0.282  0.230  0.097 -0.408  0.479 -0.413
  price4 -0.028 -0.096  0.130 -0.300  0.148  0.271 -0.424  0.411
  price5 -0.039 -0.600  0.529 -0.015  0.490 -0.123 -0.003 -0.072
 is.sale  0.062 -0.550 -0.211  0.140  0.090  0.019 -0.350  0.128
start.tue  0.156 -0.178 -0.239 -0.096 -0.195 -0.207  0.331 -0.482
     tue -0.151  0.047  0.235  0.035  0.290  0.150 -0.277  0.356
     wed  0.045  0.580 -0.324 -0.355 -0.508  0.117  0.070 -0.004
     thu -0.166 -0.336  0.420  0.097  0.300  0.081 -0.294  0.244
  length  0.037  0.261 -0.006 -0.237 -0.100 -0.022  0.155 -0.132
     apr -0.670 -0.019  0.090 -0.077  0.007  0.064 -0.010  0.045
     may -0.639  0.073  0.005  0.011 -0.048 -0.044 -0.008  0.016
     dec -0.621  0.046 -0.060 -0.125 -0.029  0.036  0.019  0.003
   d.mon -0.271  0.022 -0.043 -0.031  0.001  0.016  0.037 -0.034
   d.tue -0.327  0.006 -0.012 -0.016  0.004  0.009  0.012 -0.014
   d.wed -0.317  0.011 -0.010 -0.016  0.005  0.007  0.011 -0.010
   d.thu -0.284  0.026 -0.016 -0.015  0.003  0.007  0.018 -0.013
   dos.1  0.053  0.022 -0.017 -0.009  0.000  0.004  0.014 -0.008
   dos.2  0.033  0.017 -0.017 -0.009  0.000  0.005  0.013 -0.009
   d.fri -0.286  0.017 -0.008 -0.008  0.002  0.003  0.014 -0.007
   d.sat -0.266  0.002  0.006 -0.003  0.000  0.000  0.002  0.001
     feb -0.614 -0.006  0.088  0.092 -0.032 -0.042  0.146 -0.099
     mar -0.658 -0.048  0.038 -0.035  0.064  0.007 -0.039  0.011
     jun -0.651 -0.056 -0.014 -0.065 -0.066  0.036  0.042 -0.056
     jul -0.674 -0.083  0.074 -0.033  0.021  0.007  0.035 -0.071
     aug -0.650 -0.012  0.022 -0.016 -0.019 -0.056  0.025 -0.053
     sep -0.754 -0.072  0.054  0.069  0.025 -0.009  0.013 -0.017
     oct -0.730  0.025  0.068 -0.012 -0.004 -0.081  0.068 -0.015
     nov -0.596 -0.142  0.141  0.031 -0.025 -0.034 -0.091  0.090
         price1 price2 price3 price4 price5 is.sal strt.t    tue
numprods
    body
    home
    food
 clothes
 aveperc
highperc
  price1
  price2  0.164
  price3  0.588  0.238
  price4  0.127  0.416 -0.160
  price5  0.580 -0.002  0.308  0.155
 is.sale  0.165 -0.076 -0.014  0.102  0.038
start.tue  0.280 -0.308  0.388 -0.324  0.099  0.260
     tue -0.245  0.224 -0.389  0.284 -0.019 -0.303 -0.888
     wed -0.493 -0.199 -0.301 -0.207 -0.406 -0.502  0.071 -0.152
     thu  0.018 -0.123 -0.269  0.164  0.379 -0.234 -0.598  0.694
  length -0.165 -0.237  0.069 -0.176  0.019 -0.641  0.287 -0.137
     apr  0.023  0.059 -0.029  0.108  0.079 -0.080 -0.200  0.176
     may -0.037  0.077 -0.045  0.005 -0.200 -0.029 -0.201  0.165
     dec -0.008  0.067 -0.056  0.008 -0.034 -0.052 -0.132  0.170
   d.mon  0.001  0.006 -0.007 -0.001 -0.021 -0.025  0.066 -0.070
   d.tue  0.002  0.004 -0.002  0.009 -0.006 -0.001  0.002 -0.064
```

```
    d.wed  0.003  0.017  0.006  0.017 -0.004 -0.022  0.003 -0.015
    d.thu -0.003  0.021 -0.001  0.013 -0.008 -0.049  0.005 -0.014
    dos.1 -0.004  0.012 -0.005  0.001 -0.008 -0.106  0.005  0.017
    dos.2 -0.003  0.006 -0.008 -0.003 -0.008 -0.083  0.005  0.001
    d.fri -0.002  0.018  0.002  0.012 -0.003 -0.051  0.013  0.033
    d.sat -0.004  0.005 -0.001  0.006  0.004 -0.003 -0.005  0.004
      feb  0.160 -0.002  0.098 -0.098  0.069 -0.143 -0.102  0.076
      mar  0.164  0.051  0.091  0.037  0.056  0.001 -0.118  0.096
      jun  0.036 -0.049  0.043 -0.008  0.022 -0.051 -0.034  0.052
      jul  0.098  0.036  0.085  0.064  0.124 -0.021 -0.097  0.098
      aug -0.038 -0.046 -0.077 -0.055  0.042 -0.053 -0.135  0.140
      sep  0.106  0.051  0.034  0.045  0.088 -0.041 -0.175  0.168
      oct  0.048  0.149  0.116  0.057  0.037 -0.127 -0.163  0.165
      nov  0.028 -0.028  0.033  0.000  0.057  0.133 -0.161  0.195
             wed    thu length    apr    may    dec  d.mon  d.tue
 numprods
     body
     home
     food
  clothes
  aveperc
 highperc
   price1
   price2
   price3
   price4
   price5
  is.sale
start.tue
      tue
      wed
      thu -0.199
   length  0.429 -0.085
      apr -0.019  0.186 -0.041
      may  0.007  0.091 -0.099  0.498
      dec  0.059  0.087 -0.107  0.485  0.471
    d.mon  0.048 -0.041  0.053  0.005  0.006  0.028
    d.tue -0.004 -0.015  0.063  0.058  0.046 -0.006  0.537
    d.wed -0.052 -0.023  0.088  0.043  0.029  0.003  0.416  0.648
    d.thu -0.001 -0.067  0.108  0.016  0.002  0.002  0.381  0.503
    dos.1  0.024 -0.027  0.090 -0.024 -0.030  0.022 -0.033 -0.226
    dos.2  0.038 -0.018  0.066 -0.021 -0.022  0.021  0.004 -0.105
    d.fri -0.010 -0.030  0.088  0.004 -0.016 -0.002  0.376  0.408
    d.sat  0.001 -0.001  0.001  0.021  0.000 -0.002  0.333  0.365
      feb  0.058  0.123 -0.053  0.475  0.459  0.469  0.004  0.007
      mar -0.087  0.123 -0.068  0.517  0.513  0.474  0.005  0.046
      jun  0.013  0.154  0.025  0.509  0.491  0.474  0.020  0.043
      jul -0.069  0.156 -0.034  0.528  0.487  0.475  0.004  0.044
      aug  0.022  0.186 -0.029  0.513  0.500  0.481  0.013  0.043
      sep -0.106  0.239 -0.103  0.586  0.553  0.545  0.018  0.035
      oct -0.047  0.112  0.010  0.572  0.544  0.535 -0.005  0.025
      nov -0.186  0.193 -0.260  0.468  0.458  0.493 -0.032 -0.029
           d.wed  d.thu  dos.1  dos.2  d.fri  d.sat    feb    mar
 numprods
     body
     home
     food
  clothes
  aveperc
 highperc
   price1
   price2
   price3
   price4
```

```
   price5
  is.sale
start.tue
      tue
      wed
      thu
   length
      apr
      may
      dec
    d.mon
    d.tue
    d.wed
    d.thu  0.660
    dos.1 -0.109  0.108
    dos.2 -0.216  0.008  0.547
    d.fri  0.486  0.618  0.049  0.019
    d.sat  0.384  0.431 -0.012  0.010  0.570
      feb -0.006 -0.012 -0.010 -0.005 -0.013 -0.001
      mar  0.029 -0.016 -0.037 -0.027 -0.032 -0.019  0.495
      jun  0.027 -0.014 -0.041 -0.030 -0.032 -0.019  0.465  0.505
      jul  0.044  0.015 -0.029 -0.024  0.001  0.019  0.476  0.527
      aug  0.006 -0.022 -0.034 -0.018 -0.036 -0.001  0.473  0.494
      sep  0.022 -0.019 -0.031 -0.020 -0.018 -0.011  0.557  0.587
      oct  0.038  0.011 -0.016 -0.023  0.007  0.005  0.525  0.560
      nov -0.018 -0.048 -0.044 -0.047 -0.011  0.000  0.438  0.467
             jun    jul    aug    sep    oct
 numprods
     body
     home
     food
  clothes
  aveperc
 highperc
   price1
   price2
   price3
   price4
   price5
  is.sale
start.tue
      tue
      wed
      thu
   length
      apr
      may
      dec
    d.mon
    d.tue
    d.wed
    d.thu
    dos.1
    dos.2
    d.fri
    d.sat
      feb
      mar
      jun
      jul  0.532
      aug  0.505  0.526
      sep  0.582  0.592  0.583
      oct  0.553  0.573  0.549  0.652
      nov  0.457  0.474  0.465  0.547  0.522
```

```
Standardized residuals:
       Min         Q1         Med        Q3      Max
 -3.689739 -0.5574653 0.02155516 0.5805586 3.425508

Residual standard error: 6.559293
Degrees of freedom: 413 total; 375 residual
```

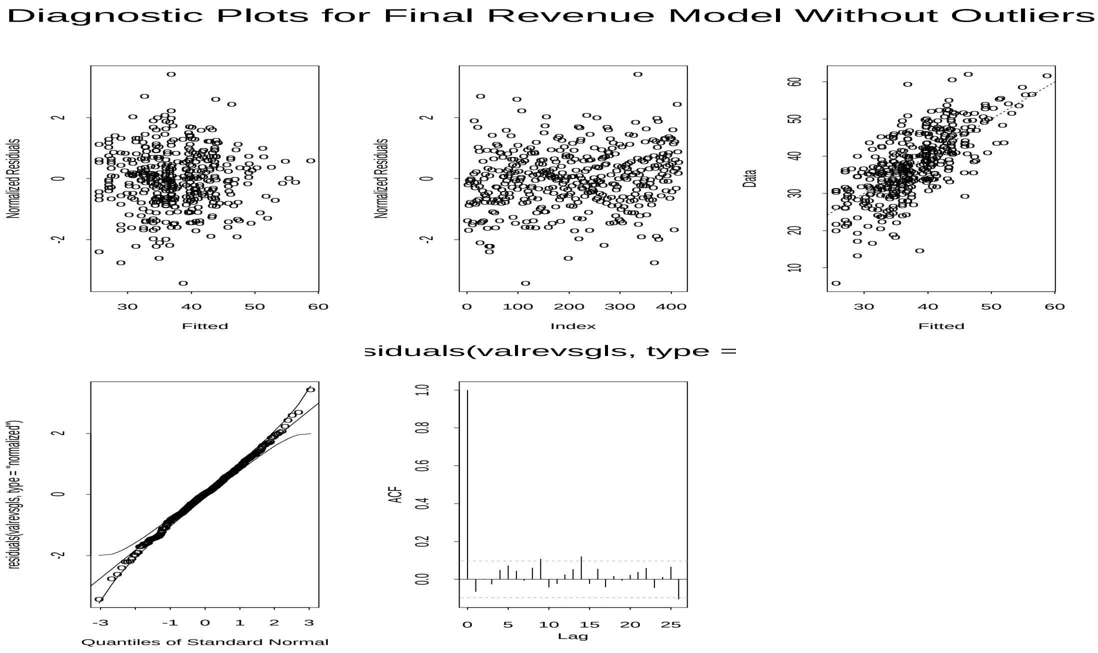

Figure 54: Diagnostic Plots for Regression of Revenue on Selected Variables without the two outliers

REVENUE PREDICTIONS–Without Outliers						
Date	Prediction	Lowest Error	Highest Error	True Value	Correct Prediction	Difference
9/5/01	38.64592	26.44952	50.84232	50.62934	T	-11.983419
9/6/01	40.08106	27.88466	52.27746	33.93184	T	6.149214
9/7/01	32.47117	20.27477	44.66757	46.04563	F	-13.574456
9/18/01	33.72362	21.59712	45.85012	46.41077	F	-12.687156
9/19/01	31.37988	19.25338	43.50638	46.07114	F	-14.691260
9/20/01	26.88664	14.76014	39.01314	36.48767	T	-9.601030
10/2/01	37.19949	24.82316	49.57582	51.69042	F	-14.490934
10/3/01	34.17862	21.80229	46.55495	41.25458	T	-7.075956
10/4/01	29.97643	17.60010	42.35276	45.89989	F	-15.923463
10/16/01	38.82160	26.30901	51.33419	50.57994	T	-11.758336
10/17/01	36.02445	23.51185	48.53704	62.04982	F	-26.025374
10/18/01	31.47536	18.96277	43.98795	52.28642	F	-20.811063
average difference: -12.7061						
t-statistic for testing if this is different than zero: -0.2118939						
p-value: 0.8360649						