The Economic Impact of Exterior Electronic Message Boards

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Executive Summary

Electronic message boards are increasingly used by businesses as exterior on-premise signage. Are these signs, which allow businesses to communicate more information at a lower cost, associated with better store performance? This research provides new insights into the benefits of investing in electronic message boards, based on the latest performance metrics from a major retailer.

- The analysis used data from 19 stores which implemented an electronic message board sometime between July 2010 and February 2012. During this period, each of the test stores went from having either no message board or a manual message board to an LED message board.

- By using a control-treatment store methodology, the Economics Center found a 2.1 percent increase in weekly store sales in the first year after installing an electronic message board.

- The increase in store performance from the electronic message board was consistent across various measures including: weekly store sales, weekly transactions, and transactions for both convenience sales and destination sales.

- Based on these estimates, the break-even figure for an electronic message board installation may be as low as 3 months and as high as 15 months – depending on labor capacity and other fixed costs. Therefore, in most cases, the installation of such a sign generally pays for itself in less than a year and contributes positively to the business bottom line for the remainder of its life cycle.

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Introduction

Certain types of retail businesses prefer high-traffic locations. Such businesses have long used supplemental message boards to inform prospective customers about their location and products. Businesses like gas stations and banks regularly provide information about the availability and price of particular items, such as gas, convenience items, loans, and savings certificates. The display of this information plays a central role in these companies' business strategies for increasing traffic and sales. Indeed, the value of a corner or other highly-visible location rests largely on the ability to use signs to inform passers-by about the availability of a business' goods and services.

One particularly important characteristic of these supplemental message boards is that they provide key information to consumers, thus lowering their cost of finding products they want to buy. This function has benefits for businesses, consumers, and the communities in which they are located (Rexhausen et al, 2012).

The subject of this case study is one of the largest retailers in its industry, with hundreds of locations across the country. It offers its customers a broad range of merchandise that includes both convenience and destination-type consumer products. This large retail chain operates in a highly competitive industry, where nearly all of the goods and services offered by its stores are also available from other retail establishments. In this environment, providing information to prospective customers about the availability of its products is essential to maintain profitability. Stores are situated in high-traffic locations, with good visibility that enables the company to employ a variety of signage strategies to drive foot traffic and sales.

At most locations, the subject retailer has at least three types of on-premise signage. First, the one or two most visible sides of the building receive standard branding and descriptive wall signage. Second, pylon and/or monument signage with the company's branding is employed along the major thoroughfare. Third, a two-sided electronic message board is placed below the largest corporate logo on a pylon or monument sign.

For the subject retailer, these signs were historically manual message boards, with plastic letters that were changed by store personal to convey new information. These messages were occasionally disrupted by windy weather and vandalism, and repairs or message changes were time consuming. Message consistency across the chain was also difficult to maintain. In recent years, the subject retailer has incorporated electronic message boards as part of its exterior signage program.[1] These electronic message boards are a key element in informing customers about things such as sales on particular products and the availability of new items. The electronic boards can be centrally controlled to ensure proper messaging, while simultaneously being customizable at the store level to provide information of value to the local community.

[1] LED signs are the most common type of variable-message electronic signs, which are sometimes referred to as digital signs.

Previous Research

In a 2011 report on "EMC and Digital Sign Issues," Freeborg, Moeller, and Drury identified a range of business and community impacts that may constitute reasons for expanding the use of electronic message boards. For businesses, these benefits include an enhanced ease of changing the sign message, which creates an opportunity to more effectively respond to the needs of potential customers, and the potential for including images, all of which lead to increased sales.

For communities, the benefits are even more numerous. Increased sales for businesses lead to increased tax revenues. By improving business viability, these signs can also reduce vacancies and blight in commercial areas. Such signs can also serve community interests by improving sign visibility, readability, and attractiveness, and by communicating public service messages. In addition, fears about safety issues appear to be misplaces, because five major studies between 2007 and 2010 found no statistical relationship between vehicular accidents and digital billboards. (Freeborg, Moeller, and Drury, 2011).

In his research, Hendrikus E.J.M.L. van Bulck (2011) surveyed 36 business establishments in Sumter SC, a dataset believed to constitute the majority of electronic sign users in the city. Van Bulck collected data on business and sign characteristics as well as attitudes about the potential benefits of these signs. Using factor analysis, van Bulck found two dimensions that underlie respondents' attitudes about their electronic signs. The first factor – Cost-Effective and Easy – reflects their views about the cost of such signs and the low level of effort required for updating their messaging. The second factor – Helps Customers – captures their attitudes about the value of electronic signs for enhancing the visibility of their businesses. Van Bulck also found that two sign characteristics were significantly related to respondents' perceptions of the signs' effectiveness. His most significant finding was that signs with one-line or three-line messages were considered less effective than signs of other lengths. He also determined that two-sided signs were seen as significantly more effective than one-sided signs (van Bulck, 2011).

Hawkins, Kuo, and Lord (2012) have studied the relationship between the installation of on-premise digital signs and traffic accidents. Through extensive research, Hawkins and his colleagues were able to identify 135 locations with accident data available, and where new digital signs were installed in either 2006 or 2007. Examining this multi-state dataset, which contained 12 times as many sites as the combined count in all related studies in the previous ten years, they found that the installation of these digital signs had no effect on the number of traffic accidents within a tenth of a mile of the sign locations. These findings held for both single-vehicle and multi-vehicle crashes.

In a 2012 study on "The Economic Value of On-Premise Signage," Rexhausen, Hildebrandt, and Auffrey included two case studies that considered the effects of electronic message boards. The first case study examined data from roughly 170 locations of an extended-stay lodging chain. Those with electronic signs had higher average occupancy rates than those with plastic signs, and this difference was most pronounced in the bottom quartile of locations. The study notes that "the performance gain from the use of electronic signs was in the range of one to two percent in the top three quartiles, but in jumps up to a ten percent advantage in the lowest quartile."

The second case study concerned the installation of a pylon video board to promote a car dealer's service business. Positive metrics for the sign change included an increase in the number of customers in the first ten months that averaged 4.5 percent every two months, an overall year-over-year increase of 6.5 percent, and a service revenue growth of 10.8 percent, compared to a 5.5 percent increase in a related national indicator.

In the course of implementing its conversion to electronic message boards, the retailer conducted exit surveys with shoppers to gain a better understanding of their views about message boards. As shown in the tables below, shopper perceptions of message boards were positive overall, and their awareness of electronic message boards was greater than for manual boards.

Table 1

Shopper Perceptions		
	Yes	No
Message board detracts from community attractiveness	7%	81%
Message board shows store cares about community	55%	10%
Message board should have community messages	67%	11%

Table 2

Shopper Awareness			
	Electronic	Manual	Gain
Read the sign	41%	28%	**+13%**
Remember the message	21%	10%	**+11%**

Overall, 30 percent of exiting shoppers read the sign, but the rate was nearly 50 percent higher among those using a store with an electronic board. Among demographic groups, the sign was more likely to be noticed by parents, African Americans, and frequent shoppers. In addition, consumers indicated a preference for monument message boards in suburban settings.

This corporate research also revealed that customers are selective about their use of these electronic signs: they report that such signs are ignored when consumers don't have any interest in store offerings or when the street has congested traffic conditions. Conversely, the messages receive attention when the prospective customer wants the information – at the point of decision about whether to stop at the business.

Finally, it was determined that prospective shoppers want timely messages about "mass appeal" products, and that "item and price" messages have a greater impact on customers. In a controlled test, such a message produced 55 percent more sales than a message that only named the item, with no price information.

Research Data Description

The analysis conducted in this paper utilizes data from 19 test stores (i.e., stores which received a new electronic message board) and 55 control stores (i.e., stores which were similar to the test stores in demographics and sales, but did not undergo a sign change). The test stores did not undergo complete signage makeovers; changes only affected the message boards, which generally represent less than one fourth of a store's total signage area.

The data in this sample ranged from July 2009 through June 2013 and was aggregated on a weekly basis. During this time period, each of the test stores went from having either no message board or a manual message board to an electronic message board. Of the sample of 55 control stores, 22 had electronic message boards and 23 either had a manual message board or no message board.

Weekly data for test stores and their corresponding control stores were normalized relative to the week in which the test store had an electronic message board installed. The week of the installation was denoted as week zero (0). For the analysis, weeks prior to the installation where denoted and -1, -2, … relative to week zero (0) and weeks following the installation were denoted 1,2,… relative to week zero (0). No other normalization techniques were utilized. Each test store was matched with an appropriate control store. For example, for a test store located in an area where residents earn only $30,000 a year, the residents' incomes for the matching control stores were nearly identical.

No data was available on a number of other factors that could affect store performance. Competition, site characteristics, management, and temporary factors such as road construction were not included in the analysis.

Outcomes of Interest

The performance variables examined in this analysis include:

- Total Store Sales
- Total Store Transactions
- Convenience Sales (All sales excluding destination sales)
- Convenience Transactions (All transactions excluding destination transactions)
- Destination Transactions

Summary Statistics

Table 3

Variable	Test Stores (Avg.)	Control Stores (Avg.)
Weekly Store Sales*	96	100
Weekly Store Transactions*	96	100
Median Age	34	34
Median Income	$62,851	$63,370
Percent White	77%	74%
Percent African American	12%	15%

* For confidentiality reasons, the control store sales and transactions data has been normalized to an index of 100.

Methodology

In developing our methodology, the Economics Center utilized an approach similar to a *Differences-in-Differences* model. In this model, we compared the performance of a test store which installed an LED message board across outcome variables for differing time periods relative to one or more control stores. The differences between the performance of the test store relative to the control store(s) was then measured and tested for statistical significance.

Identifying comparable stores to use in the analysis was an essential preparatory step in this study. The research team determined that a multi-faceted set of criteria offered the greatest potential for matching test stores to appropriate control stores. The criteria for identification of control stores are divided into two equally weighted categories: market area characteristics and store performance metrics.

Market area characteristics consisted of income, race/ethnicity, and geographic region. The retailer created a category known as "Demographic Peer Group," which combines all three of these characteristics, and this was given a weight of 0.35. Some examples of peer groups are:

- "Above Average Income ($60-80K), White (>80%), Midwest"
- "Average Income ($40-60K), White (15-40%), African American (15-40%), Hispanic, (15-40%), East."

In addition, the Economics Center decided to place greater emphasis on income compared to other demographics, so median income was given a weight of 0.15.

Store performance metrics (prior to test store changes) account for the other half of the criteria weights. In this case, we used "Weekly Total Convenience Sales" for the 2009 calendar year because this was the last full year prior to the sign changes at any of the test stores. This sales figure was given a weight of 0.35. In addition, we used customer traffic, measured as "Total Transaction Count" for the 2009 calendar year, which was given a weight of 0.15.

Control Store Pairings

Test stores were paired against control stores in three distinct approaches.

One: The sales of each of the three control stores for each test store were averaged together. This control store average was then paired with a corresponding test store for analysis. A test store was paired with the average of the control stores. Two individual underlying control stores were part of the average of multiple control stores.

Two: The Economics Center created a new set of control stores by modifying Approach One above and adding the criteria that the underlying control stores must also currently be stores with an LED message board installed. Besides adding this additional criterion, the approach is the same as in Approach One. One control store was excluded since it had a manual message board.

Three: By using the same three underlying control stores as in Approach One as a basis for each test store, the Economic Center created a set of test-control store pairs based on which underlying control store had the highest total store sales correlation during the 52 weeks prior to the sign change at the test store. For instance, test store "B" was paired with control store "B2" because its correlation, 0.667, was the highest. Detailed correlations are found below.

Result details from all three approaches can be made available upon request. The article will focus on results from approach one since the findings are similar across all three approaches.

Time-Frames Modeled

Outcome variables were analyzed across two different time frames:

1. A 4 week duration after the sign change relative to a 4 week duration before the sign change

2. A 52 week duration after the sign change relative to a 52 week duration before the sign change

Table 4

Test Store	Control Store	Correlation
A	1	0.685
B	2	0.667
C	3	0.651
D	4	0.771
E	5	0.615
F	6	0.800
G	7	0.762
H	8	0.715
I	9	0.894
J	10	0.596
K	11	0.569
L	12	0.746
M	13	0.578
N	14	0.718
O	15	0.668
P	16	0.692
Q	17	0.786
R	18	0.646
S	19	0.693

Results

Analysis of an Initial 4-Week Time Period

As shown in the second data column, the average performance of test stores relative to control stores showed positive results across all outcome variables except destination transactions. However, the p-values in columns 3 and 4 indicate that these results were not statistically meaningful.[2]

Table 5

Performance Variable	Average Difference Between Test Store and Control Store	P(T<=t) One-Tail	P(T<=t) Two-Tail
Total Sales	1.05%	0.335	0.669
Convenience Sales	1.49%	0.382	0.763
Total Transactions	1.42%	0.305	0.609
Convenience Transactions	1.74%	0.301	0.603
Destination Transactions	-0.02%	0.494	0.988

Possible reasons that we find statistically insignificant results from these early returns include: a time period too short for customers to change behaviors and/or an insufficient sample size. In addition, the time of the year when the electronic message board was installed might contribute to the lack of a significant finding. Suppose the electronic message board was installed when there were no major holidays or events upcoming for which consumers would increase their shopping behavior or look for bargains. Accordingly, in the given four week period, the consumer might not notice a new electronic message board. However, consider a period in which the electronic message board is installed just prior to a major holiday sales rush. In this case, consumers might be particularly alert to signage that might offer a bargain to the consumer. While the results of our model are robust given the scope and parameters of our analysis, possible future analysis with a larger dataset and more parameters could provide additional insights into the impact of electronic message boards over shorter durations of time.

[2] The p-value for a one-tail test is the probability that the performance measure (e.g., an increase in sales or transactions) is not greater than 0, which means that a low p-value tells us this probability is low. The p-value for a two-tail test is the probability that the true performance measure is equal to 0, which means that a high p-value tells us there is no difference between the test and control groups.

Analysis of 52-Week Tests

The results of our statistical analysis are more revealing when comparing performance in the year after the electronic message board installation relative to the year prior. Table 6 below shows that one year after installing an exterior electronic message board, stores sales increased by 2.12 percent on average. This increase in store performance holds across total sales, convenience sales, total transactions, convenience transactions, and destination transactions. The p-values for the one-tail t-test are approximately 0.2 or lower. With these results, a business owner should feel reasonably confident (about 80%) of the claim that a store's sales performance will improve after installing an exterior electronic message board, and even more confident (85-90%) that the other performance measures will improve.

Table 6

Performance Variable	Average Difference Between Test Store and Control Store	P(T<=t) One-Tail	P(T<=t) Two-Tail
Total Sales	2.12%	0.203	0.405
Convenience Sales	1.95%	0.141	0.282
Total Transactions	1.97%	0.117	0.234
Convenience Transactions	1.58%	0.137	0.275
Destination Transactions	3.22%	0.112	0.223

Total Store Sales

Total store sales for test stores relative to their paired control stores increased an average of 2.12 percent. Of the 12 test stores whose market area median income was between $35,000 and $75,000, nine of these test stores experienced relative gains in their total store sales, year-over-year, relative to their control stores' average. Of the seven test stores outside this income range, only two test stores outperformed their control store pairing. While this evidence is merely anecdotal, it would suggest that further research in the future should closely consider the impact of electronic message boards with respect to median income.

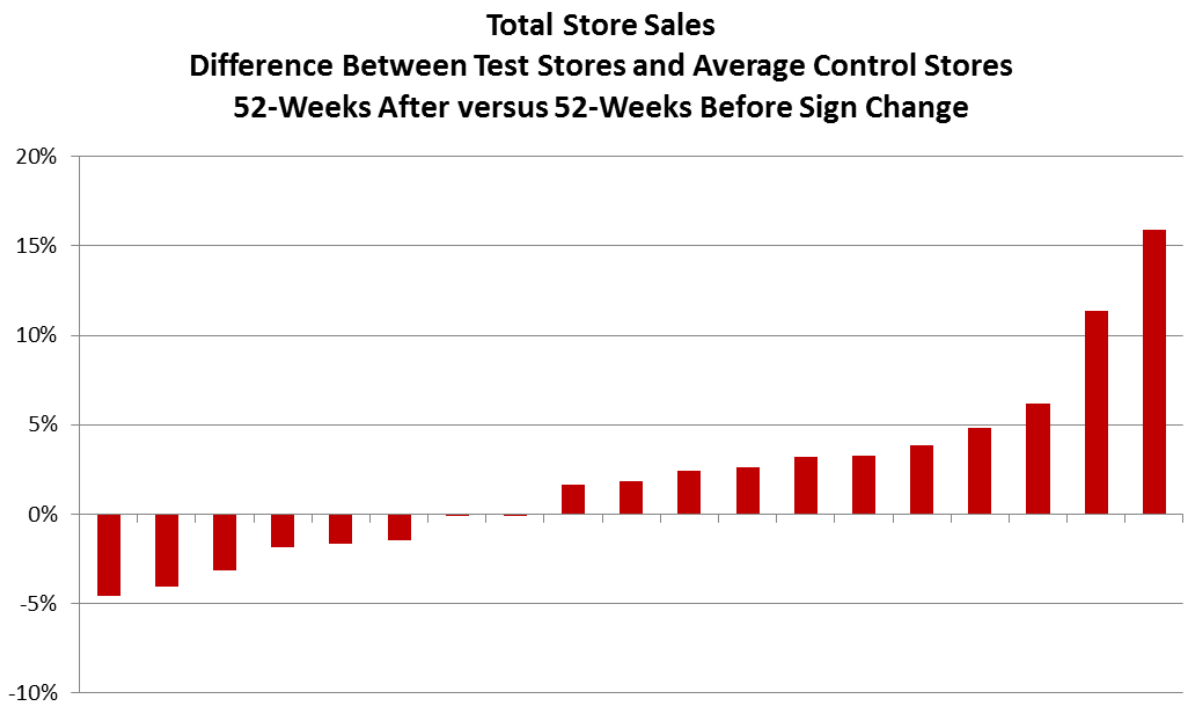
Table 7

Store	Difference-in-Differences
A	-4.06%
B	1.66%
C	2.61%
D	3.28%
E	11.37%
F	4.84%
G	-4.55%
H	-0.12%
I	1.87%
J	3.84%
K	3.21%
L	-3.16%
M	-0.04%
N	-1.87%
O	-1.67%
P	-1.46%
Q	6.21%
R	2.43%
S	15.9%
Average	**2.12%**

P(T<=t) one-tail: 0.2027
P(T<=t) two-tail: 0.4054

Table seven shows that while the average sales lift was 2.12 percent, there is considerable variability across each store. Some stores saw a slight decline, while other stores saw double-digit increases. The advantage of using a difference-in-difference model is that the idiosyncratic difference of each control-treatment store pair should produce the correct estimate on average.

Figure 1


Total Store Sales
Difference Between Test Stores and Average Control Stores
52-Weeks After versus 52-Weeks Before Sign Change
20%
15%
10%
5%
0%
-5%
-10%

Total Store Transactions

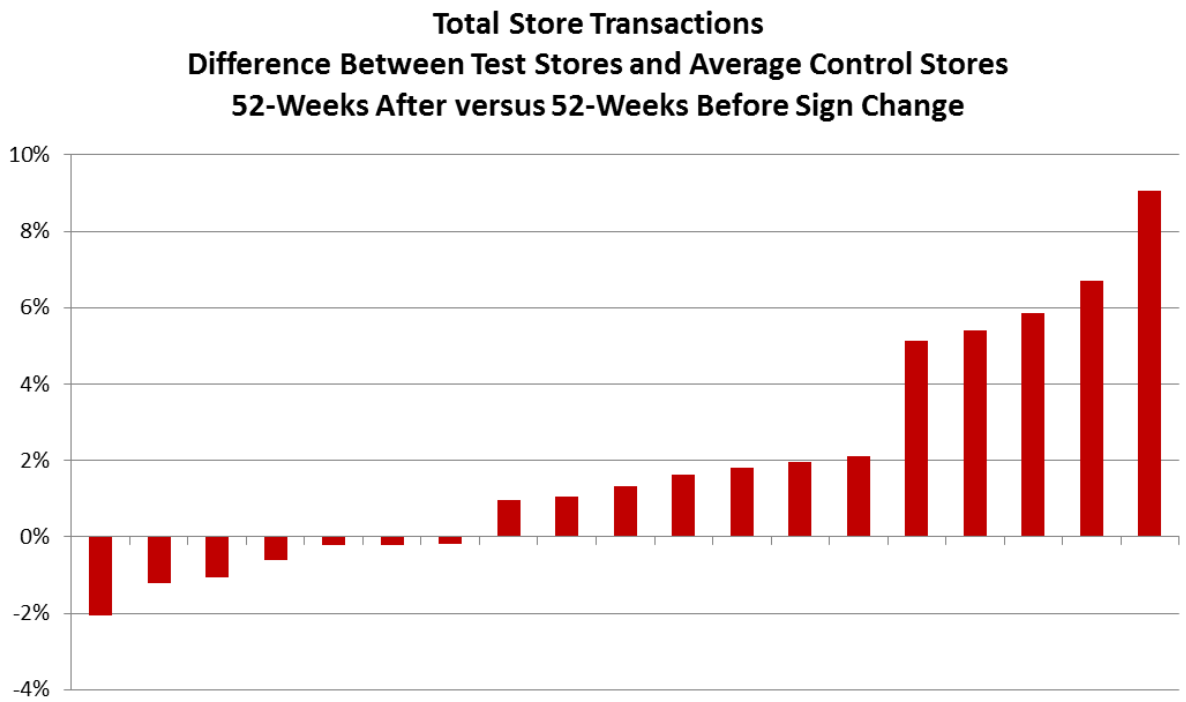
Total weekly transactions for test stores relative to their paired control stores increased an average of 1.97 percent. Of the 12 test stores whose market area median income was between $35,000 and $75,000, nine of these test stores experienced relative gains in their total store transactions, year-over-year, compared to their control store. Of the seven test stores outside this income range, only three test stores outperformed their control store pairing. The statistical significance testing is improved for transactions data relative to sales data. With a p-value of 0.12, business decision makers should feel confident about the ability of an electronic message board to improve weekly store transactions.

Table 8

Store	Difference-in-Differences
A	-2.05%
B	-0.21%
C	5.12%
D	1.81%
E	9.06%
F	2.11%
G	-0.60%
H	-0.19%
I	1.97%
J	1.63%
K	1.04%
L	1.33%
M	-1.22%
N	-0.20%
O	0.98%
P	-1.06%
Q	5.85%
R	5.40%
S	6.70%
Average	**1.97%**

P(T<=t) one-tail: 0.1168
P(T<=t) two-tail: 0.2336

Figure 2


Total Store Transactions
Difference Between Test Stores and Average Control Stores
52-Weeks After versus 52-Weeks Before Sign Change
10%
8%
6%
4%
2%
0%
-2%
-4%

Convenience Transactions

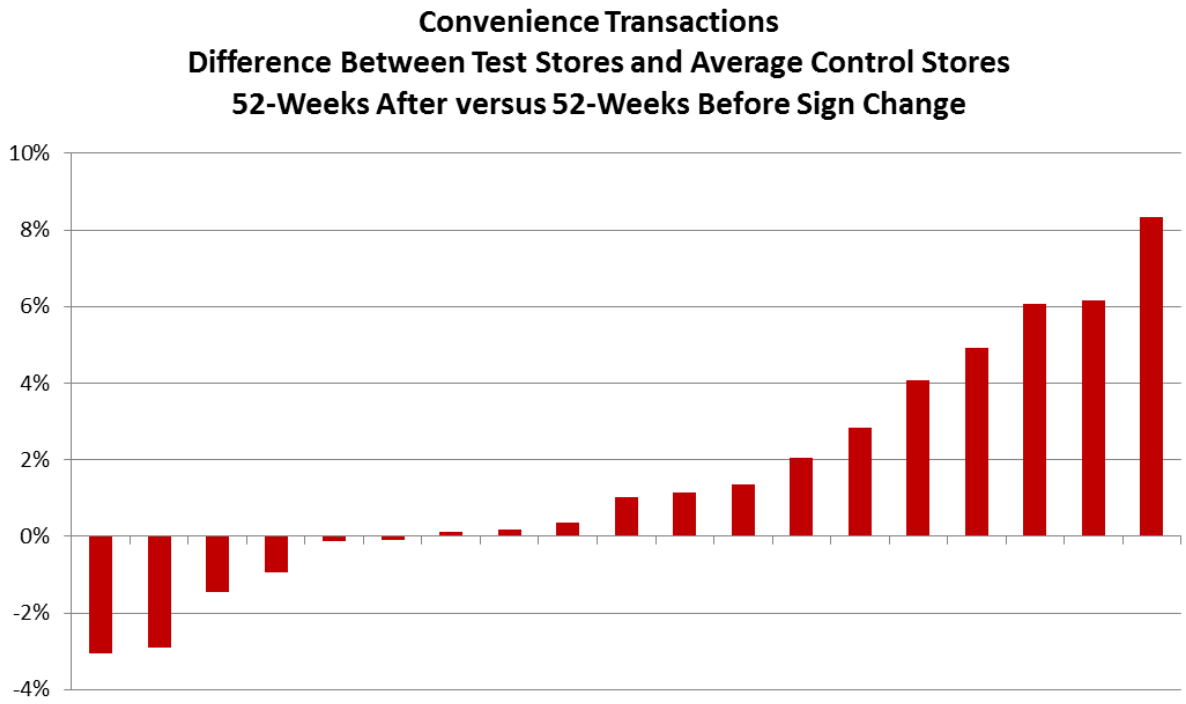
Convenience transactions include every type of purchase outside of destination purchases. Examples of these items include personal care, food, and household products. These purchases could be considered as "impulse" purchases, in that a consumer might be more likely to respond to an electronic message board advertising a price reduction in milk. Convenience weekly transactions for test stores relative to their paired control stores increased an average of 1.58 percent. Of the 12 test stores whose market area median income was between $35,000 and $75,000, nine of these test stores experienced relative gains in their convenience store transactions, year-over-year, compared to their control stores. Of the seven test stores outside this income range, only four test stores outperformed their control store pairings. With a one-tail p-value of 0.14, a decision maker should feel confident about the ability for an electronic message board to marginally improve convenience transactions.

Table 9

Store	Difference-in-Differences
A	-2.91%
B	-0.94%
C	4.91%
D	1.01%
E	8.34%
F	2.85%
G	0.11%
H	0.18%
I	1.36%
J	0.36%
K	-0.09%
L	2.04%
M	-3.05%
N	-0.12%
O	1.14%
P	-1.46%
Q	6.08%
R	6.15%
S	4.09%
Average	**1.58%**

P(T<=t) one-tail: 0.1374
P(T<=t) two-tail: 0.2748

Figure 3


Convenience Transactions
Difference Between Test Stores and Average Control Stores
52-Weeks After versus 52-Weeks Before Sign Change
10%
8%
6%
4%
2%
0%
-2%
-4%

Destination Transactions

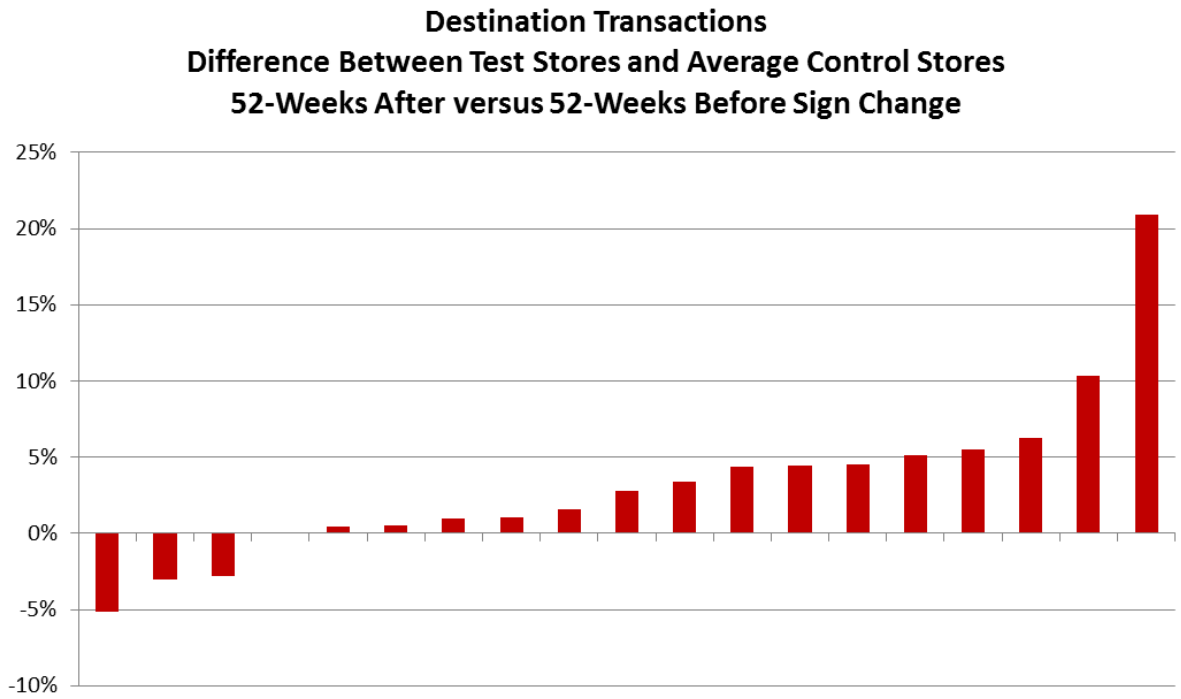
Finally, we present results for destination transactions. These are not "impulse" purchases; consumers will go to a particular retailer to purchase these items. A consumer who makes one of these purchases likely planned the trip and its subsequent purchases in advance. Weekly destination transactions for test stores relative to their paired control stores increased an average of 3.22 percent. The increase in destination transactions is likely due to the retailer advertising destination services on the exterior electronic message boards. The lift in convenience sales transactions is likely driven by the advertisements of convenience sales products, but there is an additional benefit to a retailer with the additional destination sales. These customers are likely a repeat and more valuable customer, suggesting that advertising convenience sale products can generate ancillary benefits.

Table 10

Store	Difference-in-Differences
A	1.01%
B	1.59%
C	4.56%
D	2.81%
E	10.34%
F	0.94%
G	-2.77%
H	-3.01%
I	4.44%
J	5.15%
K	6.23%
L	-5.15%
M	4.37%
N	0.01%
O	0.43%
P	0.52%
Q	5.47%
R	3.36%
S	20.93%
Average	**3.22%**

P(T<=t) one-tail: 0.1115
P(T<=t) two-tail: 0.2230

Figure 4

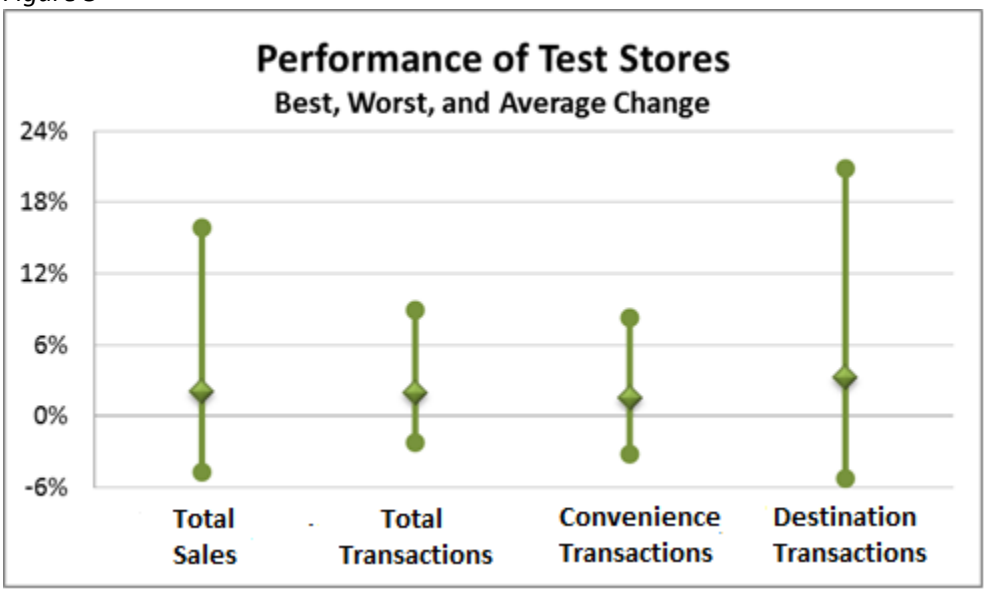


Return on Investment (ROI)

Based on conversations that the Economics Center conducted with sign installation companies, the average cost of a new electronic message board is approximately $13,000. Using the point estimate for our 52 week finding, for a store with annual sales of $10 million, the increase in sales would be close to $212,000. Using the retailer industry's gross margins and operating margins, the break-even for an electronic message board installation may be as low as 3 months and as high as 15 months – depending on labor capacity and other fixed costs. Consequently, in nearly all cases, the installation of such a sign pays for itself in less than a year and contributes positively to the business bottom line for the remainder of its life cycle.

Limitations and Conclusions

Figure 5



The chart above illustrates the improved sales performance from implementing electronic message boards. While the average point estimate across all measures is positive (and the majority of stores saw a positive increase), there is still considerable variability in store performance. Table 11 shows that 3 of the stores saw an increase in sales greater than 5 percent while no stores saw a decrease greater than 5 percent. The strongest increase in sales was over 15 percent in one store while the worst-performing store actually saw a decrease in sales of 4.5 percent after implementing the electronic message board.

Table 11

	Total Sales	Total Transactions	Convenience Transactions	Destination Transactions
Large Increase (> 5%)	3	5	3	5
Moderate Increase (2% to 5%)	6	1	4	5
Little or no change (-2% to 2%)	7	12	10	6
Moderate decrease (-5% to -2%)	3	1	2	2
Large decrease (below -5%)	0	0	0	1

These findings illustrate a potential limitation to the difference-in-differences methodology. The methodology assumes that in the absence of implementing an electronic message board, the growth trajectory of the treatment store would be the same as the matched control store. If a negative event happened at a particular store, it may inadvertently affect the results. For example, suppose that road construction occurred over an extended time period at a particular store and subsequently reduced store traffic or a new competitor moved into the market area. The decline in sales observed in the data,

despite the introduction of an electronic message board, may then be due to the road construction and not the message board. Unfortunately, the Economics Center was not able to control for all of these potential effects that may affect the store performance. Some aspects were controlled: stores were selected from metropolitan areas in the Midwest and South, and test and control stores were matched on the basis of particular market area demographics and similar store performance before the sign change. On the other hand, we had to take what was available: sign changes occurred over a period of nearly two years, in all different seasons, and under varying economic and business competitiveness conditions.

There are a variety of factors that have the potential to affect store performance, in addition to market demographics, including: store and site characteristics, competition, management, seasonality, and temporary factors such as weather and road construction. Unfortunately, we lack data on the degree to which these other variable may explain store performance. However, with a large enough sample of stores, the positive and negative "noise" in the data should cancel out and produce an unbiased estimate of the effect of an electronic message board. Future research might focus on what particular components of an electronic message board drive improved performance (e.g. the frequency of message changes, which products are featured, etc.) None of these characteristics were available to the Economics Center at the time of the study.

In conclusion, exterior electronic message boards offer business a lift in store sales performance and generate a relatively quick return on investment. While the overall 2.12 percent lift in sales is modest, in a high-volume store with low installation costs, the investment returns to using this technology can be significant.

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