ADEP WORKING PAPER SERIES

Using Daily Payment Processor Data to Determine Existence and Length of Retail Shopping Event Effects[1]

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Using Daily Payment Processor Data to Determine Existence and Length of Retail Shopping Event Effects

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Abstract
The Super Bowl is viewed as a major retail shopping event that can lead shoppers to increase their spending. The Super Bowl is played annually and has consistently been held on the first Sunday in February since 2004. This means that the Super Bowl's impact—if one exists—can differentially affect January and February retail sales depending on its date in a particular year, meeting the definition of a moving holiday for seasonal adjustment purposes. Identifying if these effects actually exist and the length of their impact is somewhat hard to do with monthly retail survey data. This paper makes use of daily aggregated payment processor data and modeling to test for Super Bowl effects in various types of retail business (e.g., grocery, electronics, clothing, etc.) and attempts to identify the length of the effects for each type of business (e.g. how many days before and after the holiday itself).

Key Words: retail, alternative data source, seasonal adjustment, business, economy

1. Introduction

Seasonal adjustment methodology for monthly retail trade estimates published by the United States Census Bureau includes adjustments for moving holiday effects. As the name suggests, a moving holiday is an event for which the date changes from year to year. Moving holidays impact a monthly time series when 1) the level of activity measured by the series changes in a predictable way as a result of the holiday, 2) the change in activity associated with the holiday spans two or more months, and 3) the proportion of the change in activity assigned to each month changes from year to year. A common moving holiday in United States economic time series is Easter Sunday, which varies in date from March 22 to April 25.[2] However, there are other holidays in the United States without a fixed date—such as Memorial Day (the last Monday in May)—that are not considered for adjustment in monthly time series because the holiday consistently falls late enough in the month that any associated change in retail activity will be completely contained within that month and will subsequently be part of the seasonal pattern for that month. For the purposes of seasonal adjustment, specifying a moving holiday effect removes the predictable variation in the level of the series associated with the holiday, which would otherwise obstruct the estimation of the seasonal pattern.

Easter, Labor Day, Thanksgiving, and Christmas are long-standing holidays that are associated with changes in consumers' retail spending behaviors. There are other events not formally recognized as holidays but nonetheless are widely thought to inspire changes to retail spending patterns, one prime example being Super Bowl Sunday. The Super Bowl is the annual championship game for the National Football League, the professional American football league in the United States. Currently, the Super Bowl is played each year on the first Sunday of February. According to a survey conducted by the National Retail Federation (NRF) and Prosper Insights & Analytics, American adults planned to spend an average of $81.30 related to Super Bowl LIII in 2019. Most consumers planned to spend money on food and beverages, but others planned to purchase team apparel, decorations, new televisions, and furniture (NRF 2019).

Anecdotal evidence, like that from the NRF, supports the exploration of a Super Bowl Sunday effect but additional information is needed to test for the existence of such an effect and the length of the effect. Identifying when there is a change in consumer spending behavior ahead of Super Bowl Sunday is critical to this analysis. Does the change happen the weekend before Super Bowl Sunday? The day before? The day of? Daily or weekly retail consumer spending data likely provide greater insight into these behavior changes than can be observed in monthly data. Currently, the highest frequency data collection the Census Bureau conducts for retail sales data is monthly. However, third-party data providers such as point-of-sale data aggregators and payment processors often have daily or weekly data available.

This paper summarizes work done to determine the existence and potential lengths of Super Bowl Sunday effects on retail sales using daily payment processor data from Fiserv, Inc. The results of this work are considered when determining if Super Bowl Sunday effects should be applied to retail estimates published in the Census Bureau's Monthly Retail Trade report.[3] Section 2 of this paper explores how alternative data sources—like payment

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[2] Moving holiday adjustments for Labor Day and for the day after Thanksgiving are also made to selected retail series.

[3] The complete Monthly Retail Trade Survey report can be found at:
https://www.census.gov/retail/index.html

processor data—are being used within the Economic Directorate of the United States Census Bureau. Section 3 provides background information on Fiserv, the alternative data source used in this research. Section 4 summarizes previous holiday effect work done using daily data. Section 5 presents the motivation behind the research and presents the methodology used to identify Super Bowl Sunday effects in the daily data. Section 6 presents the results of this work. Section 7 reviews the conclusions and proposes the next steps for this work.

2. Use of Alternative Data Sources

The Economic Directorate of the Census Bureau is responsible for statistical programs that measure the economic activity of United States businesses and government organizations. The Economic Directorate's mission is to collect quality economic data and provide statistics that are critical to understanding current conditions in the economy. These data are important to the preparation of key measures of economic activity by other government agencies, including Gross Domestic Product (GDP) estimates, benchmark input-output accounts, producer price indexes, and measures of industrial production and manufacturing capacity utilization.

Official economic statistics produced by the Economic Directorate have long served as high-quality benchmarks for data users. However, demands for more timely and more granular data, a decline in respondent cooperation and increasing costs of traditional survey data collection are making it challenging for the Census Bureau to meet its data users' needs. To meet these needs, a growing emphasis has been placed on exploring nontraditional means of collecting and obtaining data (Jarmin 2019).

The Census Bureau measures the retail economy every five years in the Economic Census and on a more frequent basis in monthly and annual surveys. In years ending in '2' and '7,' the Economic Census—a mandatory data collection—asks for detailed sales and product-level information as well as employment, payroll, and business characteristics for each physical store location that a retailer operates. [4] Data collected by the Economic Census are used to update the Census Bureau's Business Register, from which the sampling frames for many Economic Directorate surveys—including the annual and monthly retail trade surveys—are created.

Each year, the Annual Retail Trade Survey (ARTS) collects data at the company or retailer level; no individual store location data are collected.[5] The ARTS collects annual sales, e-commerce sales, end-of-year inventories, and expenses data as well as some retailer characteristics. The annual data are released approximately 15 months after the data year ends.

The Monthly Retail Trade Survey (MRTS) is a voluntary survey done at the retailer or company level and collects total sales as well as end-of-month inventories and e-commerce sales for all retail industries. Estimates from this survey are released approximately six weeks after month's end. The MRTS is a subsample of the ARTS and a reselection of the

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[4] For more information on how data are collected for the Economic Census, visit
https://www.census.gov/programs-surveys/economic-census/technical-documentation.html.
[5] For more information on how data are collected for the annual and monthly retail surveys, visit
https://www.census.gov/retail/how_surveys_are_collected.html

MRTS sample occurs approximately every five years to ensure the sample remains representative and to redistribute the burden for small- and mid-sized businesses.[6]

The timeliest measurement of the retail economy and earliest indication of nominal consumer spending produced by the government is the Advance Monthly Retail Trade Survey (MARTS). This survey measures only sales/receipts and estimates are published approximately two weeks after month's end. The MARTS is a subsample of the MRTS and this sample is selected every 2-3 years, again to ensure a representative sample and to redistribute burden. All Economic Census, ARTS, MRTS, and MARTS estimates are categorized by retail kinds-of-business categories defined by the North American Industry Classification System (NAICS).[7]

The Census Bureau has initiated a number of exploratory projects using alternative data sources. These alternative data sources include high-frequency and near real-time data such as point-of-sale data obtained from a retailer or a third party, building permit data obtained from a city government application programming interface (API), or new construction info obtained via satellite imagery. The Census Bureau leverages these alternative data sources in conjunction with existing survey and administrative data to provide more timely or more geographically granular data products and to improve efficiency and quality throughout the survey life cycle. Use of daily data from an alternative data source to inform current seasonal adjustment methodologies is an example of the latter.

Incorporating these types of alternative data sources into official government statistics has shown promise but also raises concerns related to methodological transparency, consistency of the data, information technology security, public-private partnerships, confidentiality, and the general quality of the data. Statisticians who set policy and quality standards for official government statistics are now faced with various issues surrounding third-party data. The United States Office of Management and Budget (OMB) and associations such as the American Association for Public Opinion Research (AAPOR) and the American Statistical Association (ASA) have begun looking more closely at how to evaluate the quality of third-party data and statistics derived from them (AAPOR 2015).

3. Description of Fiserv

Fiserv is a payment processing company that serves as an intermediary between a customer swiping a credit, debit, or gift card and the card's financial institution. Fiserv captures approximately 45% of all noncash transactions in the United States and processes 2,500 transactions per second worldwide. Through official government acquisition processes, the Census Bureau awarded a contract to Palantir Technologies, Inc., a software development company, that has taken Fiserv data stored on different acquisition platforms and integrated them into a single platform. This contract provided access to indexed daily, weekly, and monthly aggregates across many sectors of the economy—including the retail and service sectors—for each of the 50 states and the District of Columbia as well as for the entire United States. The daily data used for this research spanned from 2010 through 2017.

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[6] More details about the MRTS sample design can be found at:
https://www.census.gov/retail/mrts/how_surveys_are_collected.html.

[7] The Economic Census, ARTS, MRTS, and MARTS are subject to various sources of error, including imputation, estimation, or measurement, ARTS, MRTS, and MARTS are subject to sampling error.

While the Fiserv data provide a unique view into consumer spending habits, the data also have limitations that induce caution. One obvious limitation is that the Fiserv data only cover credit, debit, and gift card transactions; transactions paid in cash are not included. However, coverage of the retail sector by Fiserv data is the primary concern. Fiserv must protect the privacy and confidentiality of the companies whose data it processes so there is no way to know which companies are or are not included in the aggregated data. Additionally, companies working with Fiserv can opt out from sharing their data in the aggregated estimates that data users like the Census Bureau purchase. The primary goal of the Fiserv data was to produce more geographically granular retail estimates. Dumbacher, Morris, and Hogue (2019) used small area estimation methods to produce regional and state estimates. The uncertainty and lack of transparency regarding coverage prevents the Census Bureau from producing a data product based solely on the Fiserv aggregates as the Census Bureau must be fully transparent about its methodologies when producing official data products.[8]

Additionally, e-commerce measurement within the Fiserv data has some limitations. While all payment processor transactions have a flag for whether or not the cardholder was present for the transaction, it is unclear whether e-commerce transactions were appropriately and consistently categorized as either an e-commerce sale or a traditional brick and mortar sale. This means that e-commerce transactions that the Census Bureau would tabulate in its Nonstore Retailers breakout (NAICS 454) may instead be classified in the retailer's primary kind-of-business breakout (e.g. Sporting Goods Store (NAICS 45111) or Department Stores (NAICS 4521)). This limitation in the data prevents its use for better understanding of another e-commerce focused retail shopping event: Cyber Monday, the Monday following the Thanksgiving holiday in the United States.

Other federal government agencies have had success using the Fiserv data as a reference for decision making rather than using it to create new data products. The Federal Reserve Board has used the data to better understand consumer spending surrounding national disasters including Hurricane Matthew in 2016 (Aladangady, et al. 2016). The Bureau of Economic Analysis is using the Fiserv aggregates as inputs to machine learning algorithms for predicting the advance estimates of receipts for service sector industries (Chen, et al. 2018).

4. Previous Holiday Effect Research Done with Daily Data

As part of a pilot project conducted in 2016 with Palantir Technologies, Inc., Fiserv, and the Bureau of Economic Analysis, the Census Bureau conducted two efforts focused on holiday effects using daily data. During this pilot, the Census Bureau had access to national-level daily sales aggregates from October 1, 2012 through April 12, 2016. These aggregates were available for a select group of retail kind-of-business categories including Appliance, Television, and Other Electronics Stores (NAICS 44311), Home Centers (NAICS 44411), Supermarkets and Other Grocery Stores (NAICS 44511)[9], Family Clothing Stores (NAICS 44814), Shoe Stores (NAICS 4482), Sporting Goods Stores (NAICS 45111), Department Stores (NAICS 45211), and Warehouse Clubs and Superstores (NAICS 45291).

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[8] On July 29, 2019, Fiserv Inc. completed an acquisition of FirstData Merchant Services, Inc. Publications by Census Bureau researchers and other government agencies prior to that date may reference FirstData as the data source.

[9] NAICS 44511 excludes convenience stores.

The first seasonal adjustment research project conducted during the pilot involved the Fiserv daily data themselves. Daily data seasonal adjustment models were built and run on the daily data (McElroy, Monsell, and Hutchinson 2018). This paper extracted annual and weekly patterns as well as moving holiday effects from the daily data using an unobserved components framework. Significant holiday impacts for Super Bowl Sunday, Easter, Labor Day, Black Friday, and Cyber Monday were identified. Relevant to this work in this paper, a significant and negative Super Bowl Sunday effect was identified in the Fiserv Sporting Goods Stores (NAICS 45111) series. The Super Bowl Sunday effect identified here was just for the day of the Super Bowl itself.

The other research project focused on Easter Sunday. While the Easter[8] holiday regressor is used in X-13ARIMA-SEATS modeling for some retail series, this effect captures the change in retail spending in the eight days leading up to Easter and does not include Easter Sunday itself. But Easter Sunday is an example of a moving holiday where the day of the holiday itself impacts sales both through the behavior of consumers who reduce purchases and stores that have reduced hours or have closed for the holiday (Hutchinson and Scheleur 2017). Industry-level plots of all the Sundays for the daily data revealed noticeably depressed sales in several industries including Building Materials and Supplies Dealers (NAICS 4441). As seen in Figure 1 below, sales levels on Easter Sunday (darker/red bars) are markedly lower than any other Sunday in the time series.

An Easter Sunday regressor was then tested for inclusion in the seasonal models for MRTS series where the daily data showed evidence of an Easter Sunday effect. The significance and sign of those effects were noted and the small-sample-size corrected version of the Akaike Information Criterion (AICC) was compared between the model that included the Easter Sunday regressor and the model that did not include it. As a result of this work, the Easter Sunday effect was implemented in MRTS production seasonal models for the Building Materials and Supplies Dealers series as well as the Automobile and Other Motor Vehicle Dealers series (NAICS 4411 and NAICS 4412). Additionally, the Easter Sunday regressor was introduced in the February 2017 release of X-13ARIMA-SEATS, the seasonal adjustment software used and developed by the Census Bureau.[10] Each year, all retail series are tested for significant Easter Sunday effects and new series that have significant Easter Sunday effects have been identified.

This Easter Sunday effect work provides the framework used for the Super Bowl Sunday research: examining a third-party data source for characteristics, patterns, and trends that cannot be observed in the existing monthly Census Bureau data and then applying those findings to Census Bureau data.

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[10] For more information on the X-13ARIMA-SEATS seasonal adjustment program, please visit the X-13ARIMA-SEATS website at https://www.census.gov/srd/www/x13as/.
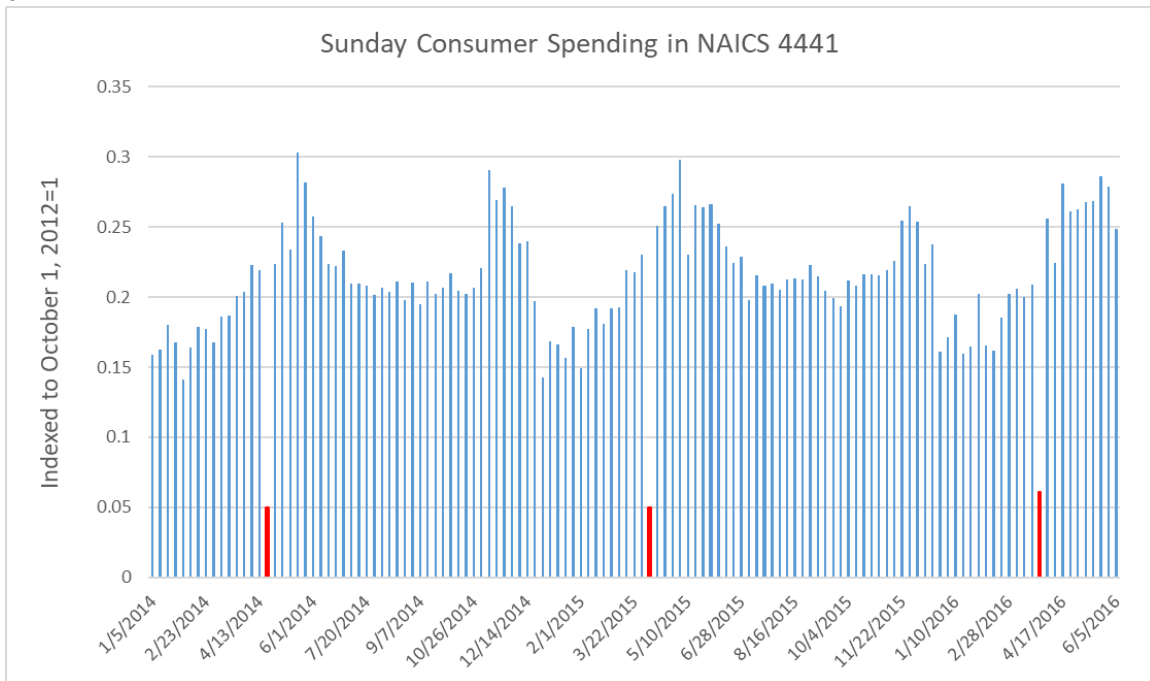
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Figure 1: Sunday Consumer Activity in Fiserv's Building Materials and Supplies Dealers (NAICS 4441) Jan 2014-June 2016
Source: Fiserv daily consumer spending data

5. Super Bowl Sunday

Since 1967, the two teams that emerge victorious from the National Football League's playoffs meet in the Super Bowl. The Super Bowl was initially played in early January but over time, the date of the game was moved to later in the month. In 2002, the Super Bowl was played for the first time in February due to regular-season game cancellations after the terrorist attacks on September 11, 2001. In 2003, the game returned to January (Robinson 2017). However in 2004, the Super Bowl was moved to the first Sunday in February and been played on this day ever since.

The Super Bowl is now a cultural phenomenon widely known for inspiring people across the country to host game-watching parties. There is growing anecdotal evidence that consumers are not only increasing grocery expenditures in anticipation of the Super Bowl, but are also buying more expensive items, including new televisions, for the big game. Some of the expenditures likely happen *before* the day of the Super Bowl. For such a major event, would people buy new televisions on the day of the Super Bowl and risk a malfunction that would prevent them from watching the game?

In its move to the first Sunday in February, Super Bowl Sunday became a moving holiday. Depending on how early or late in the month the first February Sunday falls, some pre-Super Bowl consumer spending may happen in January and the proportion of Super Bowl spending that will occur in January and February, respectively, will change from year to year. Before the availability of daily data, the selection of holiday effect length was based on subject matter knowledge and the convenience of the holiday effect regressors already included in X-13ARIMA-SEATS. The effect modeled for Easter in retail series, which like the Super Bowl always falls on a Sunday, begins eight days prior to the holiday and ends the day before the holiday. However, unlike Easter, changes in consumer behavior

associated with the Super Bowl will likely continue through Super Bowl Sunday because the game is played in the evening, leaving plenty of time during the day for last minute purchases.

The Genhol program published by the Census Bureau can create customized moving holiday regressors for use with X-13ARIMA-SEATS (U.S. Census Bureau 2015). We use Genhol to create a nine-day Super Bowl regressor describing an effect that begins eight days prior to the Super Bowl and ends on Super Bowl Sunday, denoted SuperBowl[8-0]. Since the Super Bowl first became a moving holiday in 2002, we set the Super Bowl regressor equal to zero prior to 2002.

The moving holiday regressors generated by Genhol describe an effect that induces a constant shift in the level of the series for the length of the holiday effect. In other words, the increase or decrease in the level of the series is the same throughout the entire holiday effect window. For each month, the regressor is defined by the proportion of the holiday effect window that falls within that month. For example, if the Super Bowl occurs on February 3 and we were using the nine-day effect described above, 6/9 of the effect window would fall in January and 3/9 of the effect window would fall in February. The long-term calendar month mean is then subtracted from this proportion for a given month. Therefore, the Super Bowl moving holiday regressor is nonzero for Januarys and Februarys and zero elsewhere. Without access to daily data, testing for a holiday effect is limited to adding a holiday regressor to the regression models for the MRTS series and comparing model fit diagnostics against models without the holiday regressor. When adding a user-defined regressor to a model in X-13ARIMA-SEATS, an optional test can be conducted comparing the AICC of the model with and without the holiday regressor and selecting the model with the smaller AICC.

We begin our investigation by first testing for the presence of Super Bowl effects in the monthly time series. Models are estimated for published monthly retail and food services sales by kind-of-business series, beginning January 2002 and ending February 2019, using default model selection settings in Win X-13 and including the SuperBowl[8-0] regressor described above.[11] We used the optional AICC test to determine whether to include the Super Bowl regressor in the model. Table 1 presents the t statistics for the SuperBowl[8-0] regressors that were selected into the model based on the AICC test and exceeded 1.96 in absolute value.

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[11] The time span of 2002-2019 was used to reflect the time period when Super Bowl Sunday is considering a moving holiday. Prior to 2002, Super Bowl Sunday and its effects fell exclusively in January.

Table 1: Super Bowl[8-0] effect results

NAICS	Series description	t statistic for SuperBowl[8-0] effect
442, 443	Furniture, Home Furnishings, Electronics, and Appliance Stores	2.70
4421	Furniture Stores	1.98
443141	Household Appliance Stores	2.05
444	Building Materials and Garden Equipment and Supplies Dealers	2.15
445	Food and Beverage Stores	3.28
4451	Grocery Stores	2.31
4453	Beer, Wine, and Liquor Stores	4.09
44814	Family Clothing Stores	2.25
45291	Warehouse Clubs and Superstores	2.72
454	Nonstore Retailers	-2.13
722	Food Services and Drinking Places	2.79
7224	Drinking Places	2.47
722511	Full Service Restaurants	3.18
722513, 722514, 722515	Limited Service Eating Places	2.09
7225	Restaurants and Other Eating Places	3.39

Source: U.S. Census Bureau Monthly Retail Trade Survey data, 2002-2019

Some of the results in Table 1 align with the anecdotal evidence that consumers buy food, alcohol, and televisions and other electronics before the Super Bowl. However, some of the findings are harder to explain. Why is there a positive effect for building materials and garden equipment? Is that related to the Super Bowl or is it more of winter storm effect capturing sales of shovels and sidewalk salt? While analysis of daily data may not explicitly answer these questions, it may help to better define consumer-spending habits in various retail kinds of business around the Super Bowl.

6. Using Daily Data to Identify Super Bowl Sunday Effects

6.1 Data

Raw payment processor data can have spikes and drops that are related to retailers joining and leaving the payment processor platform for varying lengths of time. Since the Census Bureau does not have access to the underlying microdata in the Fiserv dataset, the raw series is difficult to use when analyzing consumer spending behavior over time. For the purposes of this project, the chained merchant series created by Palantir and Fiserv was used. Beginning in January 2010 and available to the Census Bureau through December 2017, the chained merchant series contains only those well-behaved merchants who had transactions in the current month as well as in the previous 13 months. "Well-behaved" in this context is defined to be those merchants that have not demonstrated a ramp-up in activity on a Fiserv platform, have not exited the platform, and have not exhibited sparse and inconsistent transactions or transaction batching. Additionally, merchants that are outliers in the share of transactions or transaction growth are also excluded from the chained merchant series. These series are available for a subset of the NAICS industries

included in the MRTS estimates at the national-level and for each of the 50 states and the District of Columbia. A full list of industries by NAICS code available in the chained merchant series is available in the Appendix.

The Census Bureau had no control over this methodology but received the technical documentation explaining the method. We are comfortable using this data for this research because the data are being used to better inform methodologists regarding patterns of retail consumer behavior in the same manner other third-party data sources are typically used by Census Bureau analysts. As mentioned earlier in the paper, other government entities like the Federal Reserve Board and the Bureau of Economic Analysis are using the Fiserv data in a similar manner: as a reference point for decision-making. The Census Bureau is not using this third-party data source to create a standalone data product or to supplement existing estimates.

6.2 Methodology
To understand consumer behaviors on each day of the week, time series by day were constructed from the full time series for each of the seven days of the week for each NAICS-based industry included in the chained merchant series. We subset the daily data to include only the observations from January and February. In retail, January and February are typically two of the lower retail sales months capturing a winter and post-holiday slowdown. When measuring a Super Bowl Sunday effect, it may make sense to measure the behavior of the days leading up to the Super Bowl against other days in January and February rather than against the full time series where months are not similar in behavior to January and February.

Reflecting back to the initial work done with Easter Sunday, plots of sales by day of the week are a good starting point in identifying changes in consumer spending patterns around Super Bowl Sunday through the use of daily data. Figures 2 through 8 show the Fiserv consumer spending by days of the week for Beer, Wine, and Liquor Stores (NAICS 4453) during the months of January and February.[12] We hypothesize that we should see an increase in spending in this NAICS leading up to the Super Bowl. The darker (red) bars denote that the day of the week is either Super Bowl Sunday for Sundays or a day in the week leading up to Super Bowl Sunday (i.e., the darker (red) bars in the Saturday graph are those Saturdays that immediately precede Super Bowl Sunday). Consumer spending at Beer, Wine, and Liquor Stores is generally higher on Super Bowl Sunday and the Saturday before the Super Bowl when compared to other Sundays and Saturdays in January and February. The Friday before the Super Bowl appears to have increased spending compared to other Fridays at the beginning of series but the difference tapers off over time. The differences in the remaining days of the week are less visually apparent.

During the months of January and February, other events occur that can cause a change in consumer spending at Beer, Wine, and Liquor Stores in the Fiserv data. Observed events include New Year's Day (typically lower consumer spending is observed), Valentine's Day (typically higher consumer spending is observed), and blizzards approaching the East Coast (typically higher consumer spending is observed). For this reason, icons have been

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[12] All Fiserv retail series were analyzed in a similar matter. Due to space constraints, we are limiting the graphical results featured in the paper to the Beer, Wine, and Liquor Stores series (NAICS 4453).

added to the daily data plots in Figures 2-8 to help clarify these outliers. A yellow firework designates New Year's Day (January 1st), a pink heart designates Valentine's Day (February 14th), and a green snowflake designates days leading up to blizzards on the East Coast (February 12, 2014; January 26, 2015; January 21-22, 2016).

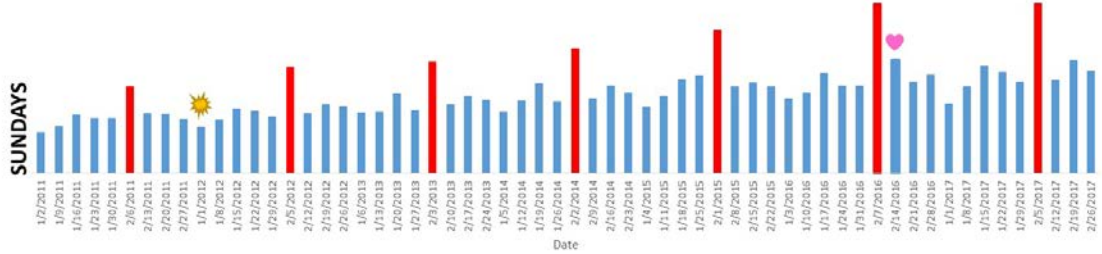**Figure 2:** Consumer spending in Beer, Wine, and Liquor Stores (NAICS 4453) for Sundays in January and February 2011-2017
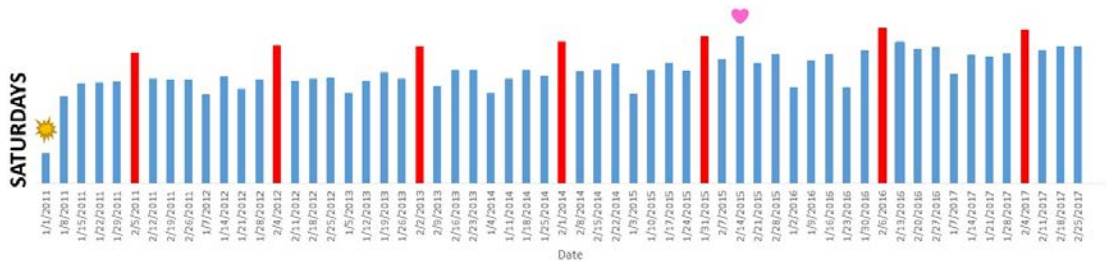**Source**: Fiserv's daily consumer spending data

Figure 3: Consumer spending in Beer, Wine, and Liquor Stores (NAICS 4453) for Saturdays in January and February 2011-2017
Source: Fiserv daily consumer spending data

Figure 4: Consumer spending in Beer, Wine, and Liquor Stores (NAICS 4453) for Fridays in January and February 2011-2017
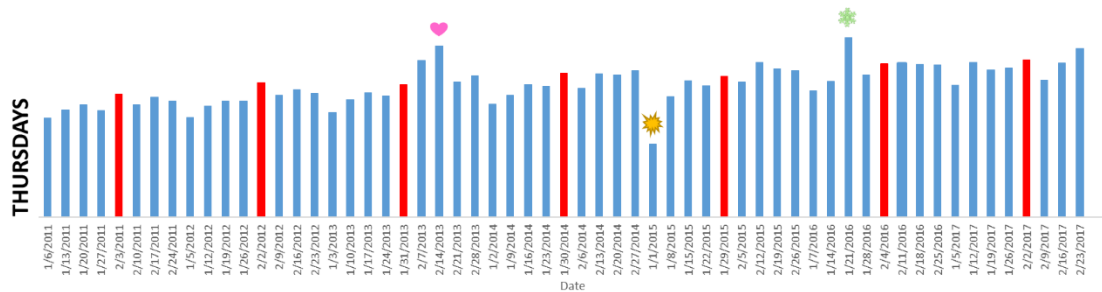**Source**: Fiserv daily consumer spending data

Figure 5: Consumer spending in Beer, Wine, and Liquor Stores (NAICS 4453) for Thursdays in January and February 2011-2017
Source: Fiserv daily consumer spending data

Figure 6: Consumer spending in Beer, Wine, and Liquor Stores (NAICS 4453) for Wednesdays in January and February 2011-2017
Source: Fiserv daily consumer spending data

Figure 7: Consumer spending in Beer, Wine, and Liquor Stores (NAICS 4453) for Tuesdays in January and February 2011-2017
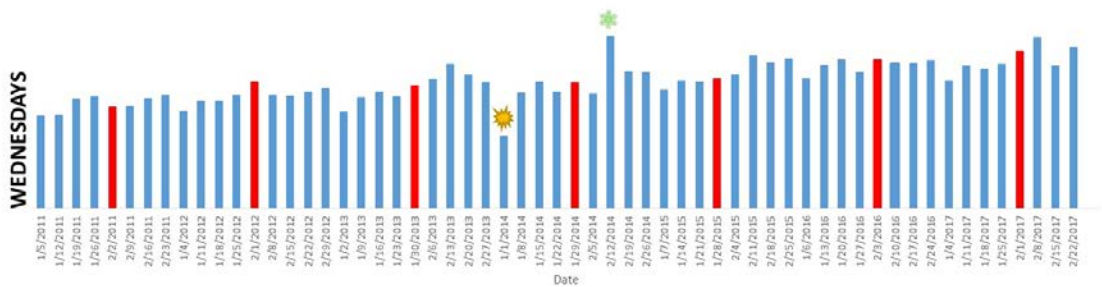**Source**: Fiserv daily consumer spending data

Figure 8: Consumer spending in Beer, Wine, and Liquor Stores (NAICS 4453) for Mondays in January and February 2011-2017
Source: Fiserv daily consumer spending data
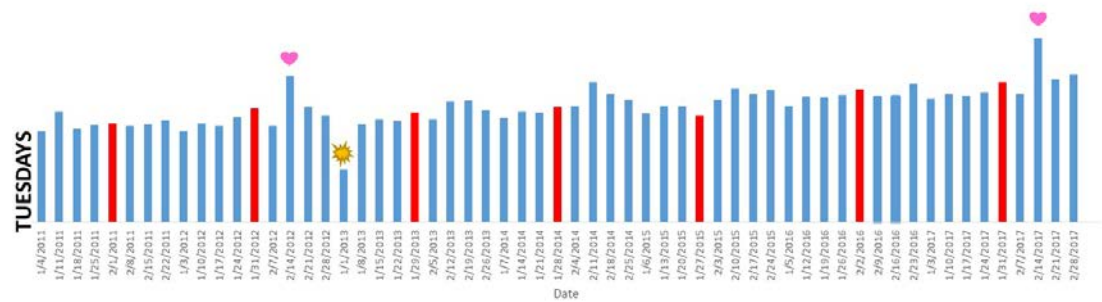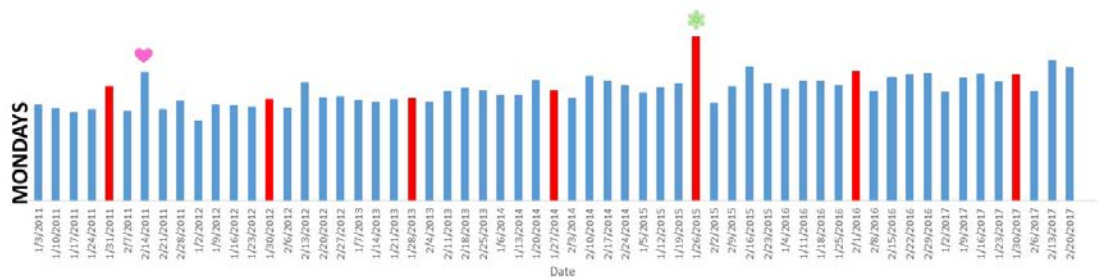
X-13ARIMA-SEATS does not currently model daily data and we wanted to start this work using an initial simple model with hopes of adding complexities later if necessary. Ordinary least squares regression was run on each day of the week series by NAICS industry using an autoregressive model specified to capture seasonality as well as effects from individual holidays that occur in January and February and may also impact retail sales. Two Super Bowl Sunday regressors are included, one to capture effects in the six days leading up to the Super Bowl as well as Super Bowl Sunday, the other regressor captures the week before Super Bowl week. This second regressor represents the week following the playoff games where the two teams that will participate in the Super Bowl are determined. We hypothesize that more expensive items, such as televisions or furniture, may be purchased further in advance of the Super Bowl, primarily during the weekend prior to the Super Bowl, to allow adequate time for delivery and setup.

We first log transform the daily data and take the first difference of the transformed series to give the series a constant mean and variance over time. Let y_t be the series of daily observations for a particular day of the week, (e.g. all of the Monday observations). Define $x_t = ln(y_t) - ln(y_{t-1})$. We then subset x_t to include only observations in January or February. We defined our regression model as follows:

$$x_t = \beta_0 + \beta_1 SB\ Week + \beta_2 Week\ Before\ SB + \beta_3 New\ Years + \beta_4 Valentine + \varphi_1 x_{t-1} + \varphi_2 x_{t-2} + \varphi_{52} x_{t-52}$$

Where

- $x_{t-1}, x_{t-2}, x_{t-52}$ are the lag 1, lag 2, and lag 52 values, respectively of the series x_t
- *SB Week* = 1 if the day falls in the six days leading up to the Super Bowl or on Super Bowl Sunday itself, 0 otherwise
- *Week Before SB* = 1 if the day falls in the week before Super Bowl Week (i.e. two Mondays before Super Bowl Sunday through the Sunday before Super Bowl Sunday) , 0 otherwise
- *New Years* = 1 if day is New Year's Day, 0 otherwise
- *Valentine* = 1 if the day falls in the 6 days leading up to Valentine's Day or on Valentine's Day itself, 0 otherwise

6.3 Results

Table 2 presents the t statistics for each NAICS industry with significant parameter estimates (α=.05) for either the Super Bowl Week regressor or the Week Before Super Bowl regression for the Saturday prior to the Super Bowl. We also present the t statistics for significant parameter estimates for other days of the week leading up to the Super Bowl. For the week prior to the Super Bowl week regressors, we found only one significant parameter estimate, Saturday for NAICS 4453. Thus, we exclude the rest of the days of the week for the week prior to the Super Bowl week from the table.

Table 2: t statistics for significant Super Bowl Sunday related effects in January and February by NAICS codes (α=.05)

NAICS Code	Super Bowl Week							Sunday before the Super Bowl	Two Saturdays before the Super Bowl
	Super Bowl Sunday	Sat	Fri	Thu	Wed	Tue	Mon		
441	-2.39								
4411	-2.32								
442	-2.80								
4421	-2.71								
4422	-3.51								
443	-2.29								
4431	-2.29								
445	2.92	3.70	2.14						
4451	2.38	2.99	2.17						
4452	3.81	3.69	2.08						
4453	5.60	4.16		2.53			2.02		2.55
446		3.03							
4461		3.03							
4512	-2.15								
452		2.02		2.18					
4521		2.61	2.56	2.17					
4531		2.35							
4533	-1.97								
4539		3.26							
454		3.60							
4543		3.60							
722	-2.20								
7221	-2.77								

Source: Fiserv daily consumer spending data

Based on the results in Table 2, we looked for consistent significant effects over a span of days. Significant effects on Super Bowl Sunday only, although interesting, would not need to be modeled as a moving holiday in the monthly time series because Super Bowl Sunday always falls in February for the span of data we considered and would be part of the normal seasonal pattern for February. For the remaining series, we generated moving holiday regressors that match the patterns we observe in the daily data. For the series without a significant effect on Super Bowl Sunday, we generate regressors to describe an effect that ends one day prior to the Super Bowl. Otherwise, the regressors describe an effect that ends on Super Bowl Sunday. We denote the Super Bowl moving holiday regressors with their start and end dates relative to Super Bowl Sunday (e.g. SuperBowl[2-0] to describe the effect that begins 2 days prior to the Super Bowl and ends Super Bowl Sunday).

To apply the findings from the daily data to the MRTS data, we include the Super Bowl regressors suggested by the daily data in the model for the corresponding MRTS times series, where available. All other model settings are kept constant, only the Super Bowl regressor was changed. No changes are made to the model for Beer, Wine, and Liquor Stores (NAICS 4453) because the Super Bowl regressor suggested by the daily data is the same as the nine-day SuperBowl[8-0] regressor we originally tested. For the series where we did not originally include the SuperBowl[8-0] regressor, we compare the model with the Super Bowl regressor suggested by the daily data to the model with no Super Bowl effect. Table 3 displays the results for the series that we tested.

Table 3: Results for Super Bowl regressors suggested by patterns in the daily data.

NAICS code	MRTS series	Super Bowl regressor suggested by daily data	t statistic	Increase in AICC compared to previous model
445	Food and Beverage Stores	Super Bowl[2-0]	2.77*	2.97
4451	Grocery Stores	Super Bowl[2-0]	1.84*	1.87
4453	Beer, Wine, and Liquor Stores	Super Bowl[8-0]	4.09*	0.00
446	Health and Personal Care Stores	Super Bowl[1-1]	1.64	
4461	Pharmacies and Drug Stores	Super Bowl[1-1]	1.09	1.12
452	General Merchandise Stores	Super Bowl[3-1]	0.36	-0.31
4521	Department Stores	Super Bowl[3-1]	0.04	2.25
454	Nonstore Retailers	Super Bowl[1-1]	-1.66*	1.74
4543	Fuel Dealers	Super Bowl[1-1]	-1.64	-0.49

* indicates the model with the Super Bowl regressor selected into the model by the AICC test compared to the model with no Super Bowl regressor
Source: U.S. Census Bureau Monthly Retail Trade Survey data, 2002-2019

In each case where the Super Bowl regressor is included in the model via the AICC test, the model fit is slightly better with the nine-day holiday regressor we originally tested as shown by an increase in the AICC presented in Table 3. Only General Merchandise Stores (NAICS 452) and Fuel Dealers (NAICS 4543) showed a decrease in the AICC, although these decreases are very small. Food and Beverages Stores (NAICS 445), Grocery Stores (NAICS 4451), and Beer, Wine, and Liquor Stores (NAICS 4453) are the three NAICS industries that would be the strongest candidates for implementing a Super Bowl Sunday effect of some length as an effect is present in the MRTS data and is supported by consumer spending patterns in the Fiserv daily data. The negative Super Bowl Sunday effect in Nonstore Retailers (NAICS 454) is somewhat puzzling as it appears to be driven by Fuel Dealers (NAICS 4543) in the Fiserv data. Anecdotally, it is difficult to link depressed sales in fuel dealers to Super Bowl Sunday; it may in fact be related to fuel prices in winter but that would require further investigation.

For other NAICS industries, the significant Super Bowl Sunday effects in the Fiserv data are not found in the MRTS data or vice versa. One possible reason is that as stated before, the coverage of retailers in the Fiserv data is a relative unknown. So while we can hypothesize that spending at the Fiserv subset of grocery and liquor stores is representative of Super Bowl Sunday spending in the retail universe, it is difficult to hypothesize the same about department stores or health and personal cares stores where individual retailers may have markedly different consumer compositions.

7. Conclusion and Next Steps

Anecdotal evidence has long suggested that consumer spending behaviors may change as consumers prepare to watch the Super Bowl and plan Super Bowl parties. When the Super Bowl was moved to be played on the first Sunday of February, it became a moving holiday that if significant would shift sales impacts between January and February from year to year. Monthly data reported to the Census Bureau's Monthly Retail Trade Survey have made it difficult to discern the impact of the Super Bowl in a meaningful way based on data-driven evidence. Daily payment processor data from a third-party data source offer a starting point for finding evidence of a change in consumer spending related to the Super Bowl or other nationally recognized events. Based on the findings above, using daily payment processor data from Fiserv, it is clear that there is a change in consumer spending behavior in the days leading up to Super Bowl Sunday, particularly when it comes to spending on food, beverages, and alcohol. However, for most series where an effect was detected in the daily data, the Super Bowl effect length suggested by the daily data did not produce a superior model fit in the monthly series compared to the originally tested Super Bowl [8-0] effect (with the exception of Beer, Wine, and Liquor Stores series where the daily data confirmed the Super Bowl [8-0] effect). Implementing a Super Bowl [8-0] effect in these series for the Monthly Retail Trade Survey estimates may produce an improvement in the seasonally adjusted estimates.

Using a third-party data source to make this kind of decision does have risk though. The coverage of the Fiserv data is an unknown. It may make sense to pursue another third-party data source to verify our findings. We would like to refine the model used in this work more so that it can be applied to other third-party data sources to provide consistent results over time.

The Super Bowl moving holiday regressors used in this research all described constant changes to the retail time series for the entire Super Bowl effect window. For future research, alternative definitions of the Super Bowl moving holiday regressors, such as effects that increase or decrease linearly or exponentially leading up to the Super Bowl could be considered.

The Census Bureau continues to pursue retail estimates at more granular geographies. If those estimates are developed, using the daily data to find Super Bowl Sunday effects at these geographies will be an interesting exercise to pursue more. We have begun preliminary exploratory analysis on states that either hosted the Super Bowl or were home to one of the participating teams. In this preliminary work, we have observed large increases in activity in the week leading up to the Super Bowl in some retail kind-of-business categories. We plan to continue this research to quantify these increases and further investigate changes in retail behavior in states with a direct connection to a given year's Super Bowl.

Acknowledgements

References

Aladangady, A., Aron-Dine, S., Dunn, W., Feiveson, L., Lengermann, P., and Sahm, C. (2016). The Effect of Hurricane Matthew on Consumer Spending, FEDS Notes. Washington: Board of Governors of the Federal Reserve System, December 2, 2016, https://doi.org/10.17016/2380-7172.1888. Accessed online 6/2/2019.

American Association for Public Opinion Research (AAPOR). (2015). AAPOR Report on Big Data, AAPOR Big Data Task Force 2015.

Chen, J., Dunn, A., Hood, K., Driessen, A., and Batch, A. (2018). Machine Learning for National Economic Accounts, https://www.bea.gov/system/files/2018-11/2018-11-06-JeffChen-ACM-nn-wide.pptx. Accessed online 6/2/2019.

Dumbacher, B., Morris, D.S., and Hogue, C. (2019). Using Electronic Transaction Data to Add Geographic Granularity to Official Estimates of Retail Sales. Journal of Big Data 6(80). https://doi.org/10.1186/s40537-019-0242-z

Hutchinson, R. J., and Scheleur, S. A. (2017). Using Big Data to Enhance US Census Bureau Economic Data Products. Proceedings of the American Statistical Association, Business and Economic Statistics Section.

Jarmin, R. S. (2019). Evolving Measurement for an Evolving Economy: Thoughts on 21st Century US Economic Statistics. Journal of Economic Perspectives 33 (1), 165-184.

McElroy, T. S., Monsell, B., and Hutchinson., R. (2018). Modeling of Holiday Effects and Seasonality in Daily Time Series. Center for Statistical Research and Methodology Report Series RRS2018/01. Washington: US Census Bureau. https://www.census.gov/srd/papers/pdf/RRS2018-01.pdf

National Retail Federation. (2019, January 24). Consumers Say They'll Spend an Average $81 on Super Bowl. Retrieved from National Retail Federation Web site: https://nrf.com/media-center/press-releases/consumers-say-theyll-spend-average-81-super-bowl. Accessed online 6/2/2019.

Robinson, E. (February 5, 2017). How 9/11 Changed the Super Bowl Forever, https://www.ozy.com/flashback/-how-9/11-changed-the-super-bowl-forever/75330. Accessed online 6/2/2019.

U. S. Census Bureau (2015), *Genhol Documentation,* U. S. Census Bureau, U. S. Department of Commerce https://www.census.gov/srd/www/genhol/genhol_run.html Accessed online 6/19/2019.

Appendix

List of NAICS codes included in the Fiserv Chained Merchant Series

NAICS code	Description	NAICS code	Description
441	Motor Vehicle and Parts Dealers	451	Sporting Goods, Hobby, Musical Instrument, and Book Stores
4411	Automobile Dealers	4511*	Sporting Goods, Hobby, and Musical Instrument Stores
4412*	Other Motor Vehicle Dealers	4512*	Book Stores And News Dealers
4413	Automotive Parts, Accessories, and Tire Stores	452	General Merchandise Stores
442	Furniture and Home Furnishings Stores	4521	Department Stores
4421	Furniture Stores	4529	Other General Merchandise Stores
4422	Home Furnishings Stores	453	Miscellaneous Store Retailers
443	Electronics and Appliance Stores	4531*	Florists
4431*	Electronics and Appliance Stores	4532*	Office Supplies, Stationery, and Gift Stores
444	Building Materials And Garden Equipment and Supplies Dealers	4533*	Used Merchandise Stores
4441	Building Materials and Supplies Dealers	4539*	Other Miscellaneous Store Retailers
4442*	Lawn And Garden Equipment and Supplies Stores	454	Electronic Shopping and Mail-Order Houses
445	Food and Beverage Stores	4543*	Direct Selling Establishments
4451	Grocery Stores	721**	Accommodation
4452*	Specialty Food Stores	7211**	Traveler Accommodation
4453	Beer, Wine, and Liquor Stores	7212**	RV (Recreational Vehicle) Parks and Recreational Camps
446	Health and Personal Care Stores	722	Food Services and Drinking Places
4461*	Health and Personal Care Stores	7221*	Full-Service Restaurants
447	Gasoline Stations	7222*	Limited-Service Eating Places
4471*	Gasoline Stations	7223*	Special Food Services
448	Clothing and Clothing Accessories Stores	7224	Drinking Places
4481	Clothing Stores		
4482	Shoe Stores		
4483*	Jewelry, Luggage, and Leather Goods Stores		

* These NAICS levels are not published as part of the Monthly Retail Trade report. More detailed levels that sum to these levels or equivalent higher levels may be published as part of the Monthly Retail Trade report

** These NAICS levels are published as part of the Quarterly Services Survey (QSS). More information on QSS is available here: https://www.census.gov/services/index.html