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## **Measuring Wisconsin Economic Activity Using Foot Traffic Data**

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### **Overview**

The COVID-19 pandemic is leading to unprecedented social and economic disruptions around the globe. The economies in many locations have ground to a halt, as social distancing measures to slow the spread of the virus have increasingly led to businesses being shut down and workers ordered to shelter in place. While there has been an immense reduction in economic activity, there have been relatively few measures of just how severe the impact has been.

In this brief I analyze a measure of economic activity using a new data source of foot-traffic in commercial locations. I focus on year-over-year same-location changes in the state of Wisconsin, and find that there was roughly a 52% drop in overall activity during the last two weeks of March 2020 compared to 2019, which fell further to a 59% decline during the week of April 12-18.

The declines have been even more severe in some industries, with roughly 75% drops for hotels and 70% for restaurants. Grocery stores are the only retail sector seeing relatively strong activity, with activity off only 8-10% for most of the past six weeks. While non-essential retail stores have closed, grocery stores have remained open and activity at times has spiked. With the closing of UW-Madison, the Madison metro area saw a larger 70% decline in activity in early April.

However there has been a partial recovery over the last two weeks, with an easing of some restrictions and a cutback in social distancing, with total activity down 45% during the week ending May 2. Retail trade led the recovery, going from down 44% the week of April 12 to down 22% the week ending May 2. Over the past two weeks, there was also modest recovery in accommodation and food services, health care, and finance, all of which saw relative gains of 10-15 percentage points.

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## Background

As the COVID-19 pandemic has spread across the country, a number of increasingly stringent social distancing measures have been introduced to slow the spread and mitigate the impact of the virus. The application of the social distancing measures has varied across locations and over time, and the impact is very different across industries.

In Wisconsin, from mid-March on the state moved in steps toward implementing stronger measures, banning gatherings of specified sizes, closing restaurants, and then implementing the “Safer at Home” order on March 25. This order closed non-essential business and imposed severe travel restrictions. For example, grocery stores have remained open and have seen an occasional spikes in demand, while movie theaters and non-essential retail stores (among many other businesses) have closed. With dining areas of restaurants closed, many have switched to emphasize takeout and delivery service. Moreover, the guidelines for individuals have stressed the need to limit interactions and travel, driving a reduction in demand.

All of these restrictions have clearly meant a dramatic reduction in economic activity, but it has been difficult to gauge how large the decline has been. Official data documenting the decline will not be released for weeks, or even months, to come. For example, official employment data for Wisconsin in March was released on April 17. But this survey only covered the first half of March, so it will take another month after to measure the declines associated with COVID. Official measures of the impact on sales and incomes in the state will take even longer, as for example, the first quarter personal income data will not be released until the end of June.

The lags in official data releases make clear the need for new high-frequency indicators in a rapidly-evolving crisis. In this brief I analyze a new data source measuring economic activity based on detailed foot traffic patterns at commercial locations. I use this data to document the year-on-year daily change in same-location foot traffic at different commercial locations around the state of Wisconsin. In addition to the overall measure, I break out the activity changes by industry and metro area.

## Data Source

The data in this brief was provided by SafeGraph. In particular, I use the SafeGraph Patterns dataset, which measures foot-traffic patterns to 3.6 million commercial points-of-interest from over 45 million mobile devices in the United States. The population sample is a panel of opt-in, anonymized smartphone devices, and is well balanced across USA demographics and geographies. In addition to the individual data being anonymized, the SafeGraph only reports certain place traffic and data aggregations. The patterns data describe how many people visit a location, how long they stay, where they came from, where else they go, and more. This data provides incredible detail on the activity of a sample of roughly 10% of the US population. I focus on the state of Wisconsin, where the sample includes 678,514 devices, more than 11% of the population.

SafeGraph provides daily observations on an evolving panel of locations that include at least 5 visits from the sample of devices. The data is typically released monthly, but has

been released weekly starting in March 2020 (which also includes hourly data). To deal with changes in the panel over time, I focus only on locations that were in the sample in March 2019 and each week in March 2020. Thus I do not capture the entry or exit of locations, which means a loss of a fair number of observations. The March 2019 sample has over 63,000 observations and most of the weekly March 2020 data sets have over 70,000, but the joined data set of continuous observations includes roughly 50,000 locations. While this approach does have limits, it allows for a clear comparison of same-location changes in traffic, eliminating changes due to the sample makeup. In addition to considering statewide traffic, I also focus on the two largest metro areas (MSAs) in the state: Milwaukee (13,013 locations), Madison (6,388 locations). As discussed below, I also break out the results into broad industries (using two-digit NAICS codes) as well as finer industries (four or five digit NAICS codes).

Since I focus on overall activity, I use foot traffic measured as visits per day per location. While this measure is clearly correlated with sales, especially for retail locations, it is also clearly imperfect. The number of visits does not capture changes in the ratio of visitors to buyers or changes in sales per buyer. Moreover, as noted above, many stores and restaurants have increased their delivery business during the COVID-19 pandemic and these delivery transactions are missed, although takeout orders for pickup would still be captured. As I showed in [other work](#), consumers have shifted substantially toward on-line purchases, and are also buying more on each of their less frequent visits to stores. The foot traffic in this brief thus is best as a measure of in-store transactions, which is only part of sales. In future work, I will match the foot traffic data up with other measures of sales and economic activity to get a better sense of their relationship. As noted above, the SafeGraph data set also included measures of the demographic characteristics of the visitors, as well as more detail on length of visits, other locations visited, and so on. This data could provide additional useful detail for this comparison, as well as for other purposes, such as the impact of mandated shut-downs vs. voluntary social distancing.

### Changes in Economic Activity

As a baseline measure of the changes in economic activity due to COVID-19, I look at the aggregated daily number of visits across roughly 50,000 continuously-sampled locations in Wisconsin in March and early April of 2019 and 2020. These aggregates are shown in Figure 1. Because of the strong day-of-week effects, the data are aligned starting with the first Sunday in March (3/3/19 and 3/1/20). For simplicity I will refer to the 2020 date in what follows. The visit data for the two years show similar patterns for the first 13 days in the month, with similar daily fluctuations and the 2020 data running roughly 10% ahead of the 2019 values. But beginning on March 13, the two series start to diverge, with 2020 dropping dramatically until finally stabilizing at a lower level over the final few weeks. A sharp drop on Easter Sunday, April 12 is also apparent. But from that low point, activity has recovered slightly over the last two weeks, although activity still remains far below 2019 levels.

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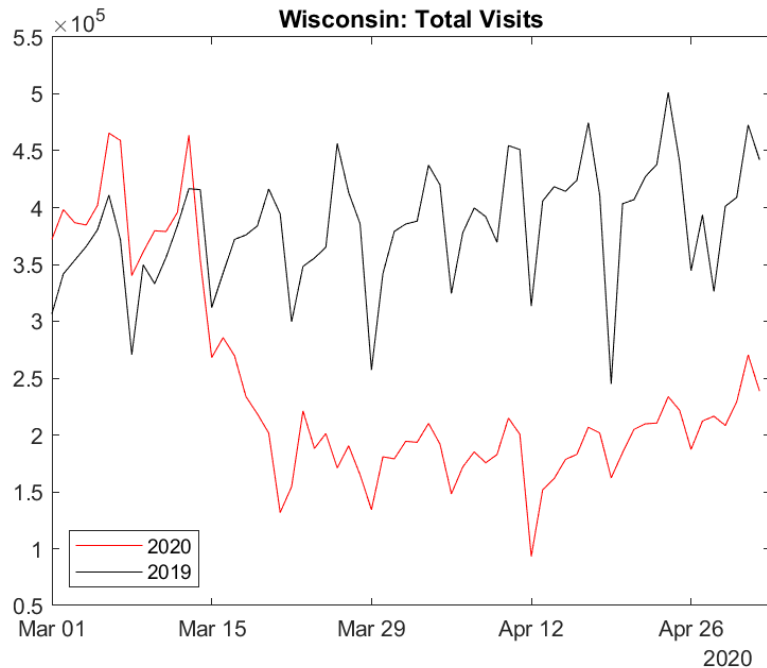


Figure 1: Total same-location visits in Wisconsin during 2020 vs. the same period in 2019.

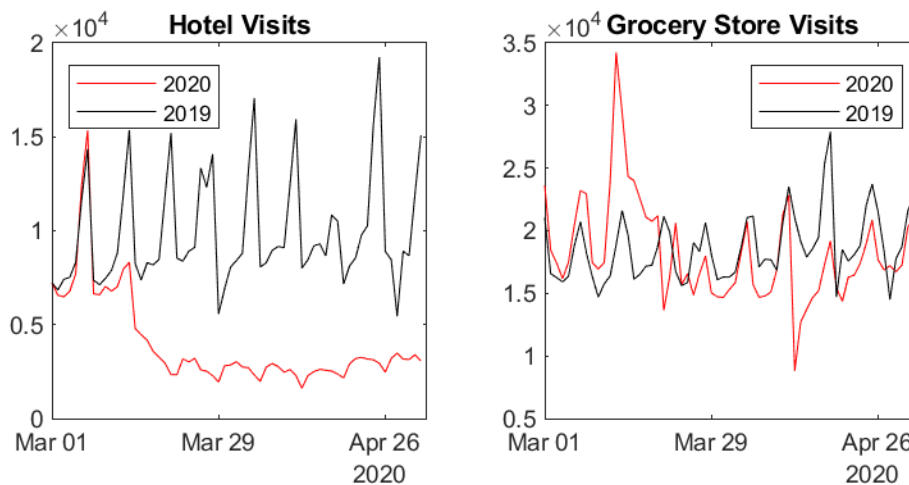


Figure 2: Total same-location visits for hotels and grocery stores in Wisconsin during 2020 vs. the same period in 2019.

The timing of the relative decline in activity coincides with the worsening of the COVID-19 situation in Wisconsin: on March 12, Governor Evers declared a public health emergency and UW-Madison announced that it would be canceling in-face classes (initially for a period of weeks), on March 16 gatherings of more than 50 people were prohibited, on March 17 malls, restaurants, and bars were closed and the limit on gatherings was tightened to 10 people, and then finally on March 25 the “Safer at Home” order closing all non-essential businesses went into effect. This order was later extended until May 26, although there have been some slightly relaxations recently (for example allowing curbside pickup & drop-off from some non-essential retail & services).

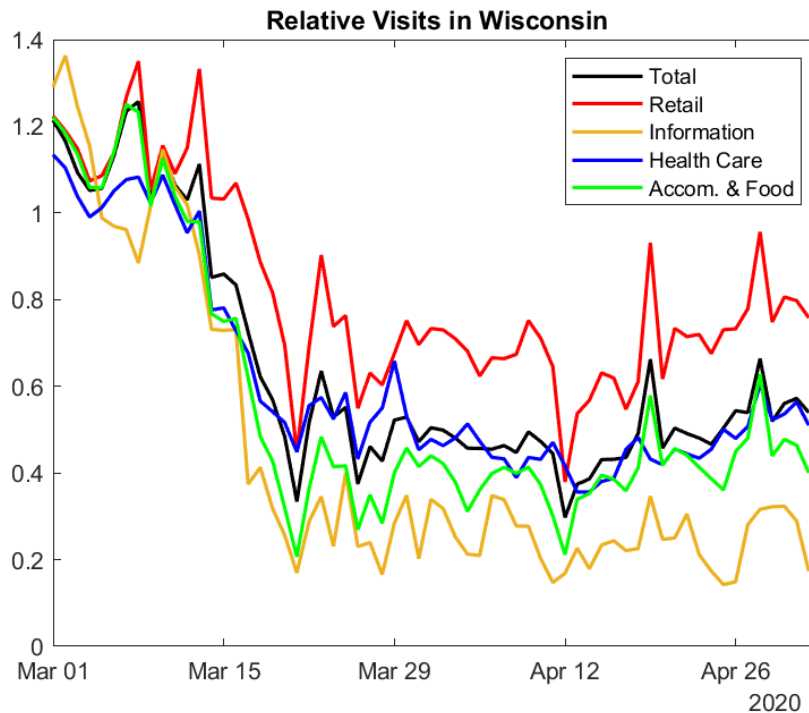


Figure 3: Relative same-location visits for all locations and select industries in Wisconsin during 2020 vs. the same period in 2019.

The changes are even more notable when comparing across different types of businesses. Figure 2 shows the total number of visits at hotels (NAICS 721110) and grocery stores (NAICS 445110). The hotel visits track each other quite closely for the first ten days in March, then start to diverge during the second week, with 2020 plummeting in the third week. This is consistent with how the crisis evolved: initially many people cut back on vacations and inessential travel, until in very rapid succession most travel altogether came to a halt. Grocery stores have fared quite differently: 2020 visit traffic ramped up and spiked in the middle of the month as people stocked up in preparation for lockdowns, before leveling off around the same values as 2019 for mid-March and early April. A sharp drop on Easter Sunday led to a further decline that week, before recovering over the last two weeks.

In the rest of this brief, for ease of presentation and interpretation, I focus on relative visits, defined as the ratio of same-location visits per day in 2020 over the corresponding value in 2019. Table 1 lists the decline in relative visits for selected industries, grouped by NAICS codes, and Figure 3 plots a select number of these industries. Since the dataset focuses on commercial foot traffic, industries not shown have few visits or none at all. The table reports the change in visits over the final six weeks of the sample.

Overall, the declines across all locations have been severe: from a 52% drop early on, ticking down to a decline of nearly 60% in the week of April 12, before recovering somewhat over the last two weeks of the sample. Not surprisingly, the largest declines have been in industries that have effectively shut down: education (schools), information

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NAICS Code	Industry Title	Change 3/22- 3/28	Change 3/29- 4/4	Change 4/5- 4/11	Change 4/12- 4/18	Change 4/19- 4/25	Change 4/26- 5/2
--	All Locations	-52.5	-52.2	-54.8	-59.1	-50.8	-44.5
31-33	Manufacturing	-47.1	-40.3	-61.4	-62.3	-61.6	-54.9
42	Wholesale Trade	-42.9	-43.1	-51.7	-54.0	-46.7	-30.6
44-45	Retail Trade	-33.5	-30.8	-33.7	-44.1	-29.5	-22.2
445110	Supermarkets & Grocery Stores	-6.7	-7.5	-10.9	-32.2	-10.5	-6.3
48-49	Transportation and Warehousing	-49.6	-47.9	-50.6	-59.7	-50.4	-29.2
51	Information	-76.1	-75.3	-75.0	-78.6	-78.7	-75.0
52	Finance and Insurance	-37.1	-33.4	-44.4	-44.7	-44.7	-27.9
53	Real Estate Rental and Leasing	-50.2	-48.9	-49.1	-58.7	-43.6	-43.7
61	Educational Services	-83.5	-87.7	-89.3	-89.0	-87.6	-84.8
62	Health Care and Social Assistance	-47.9	-51.5	-57.7	-60.9	-55.9	-46.7
71	Arts, Entertainment, & Recreation	-67.2	-67.0	-68.1	-72.4	-65.0	-56.9
72	Accommodation and Food Services	-66.0	-61.8	-63.5	-64.8	-58.0	-53.7
722110	Hotels and Motel	-76.2	-74.1	-76.0	-74.6	-73.7	-67.5
722511	Full-Service Restaurants	-70.5	-67.5	-70.6	-71.6	-65.4	-62.2
81	Other Services (except PA)	-45.2	-44.4	-50.2	-57.5	-50.2	-37.6
92	Public Administration	-36.4	-33.0	-38.9	-45.1	-34.4	-10.8

Table 1: Relative same-location visits for selected industries in Wisconsin during 2020 vs. the same period in 2019. Averages over the noted weeks.

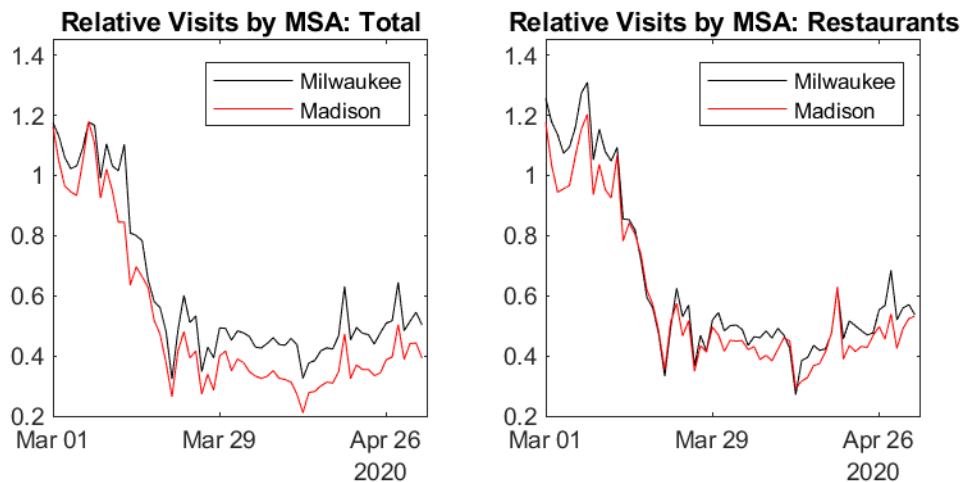


Figure 4: Relative same-location visits for all locations and for restaurants in the Milwaukee and Madison metro areas during 2020 vs. the same period in 2019.

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(especially movie theaters), and accommodation and food services (hotels and restaurants). While full-service restaurants have been able to salvage some revenue by moving to takeout and delivery, they have seen a substantial drop in activity.

Retail has seen the smallest overall decline of roughly 30-33%, over the first few weeks, then falling off to 44% on the week of April 12, before recovering over the past two weeks. However economic activity varies dramatically across the industry. Many retail operations have closed down, but essential retail businesses and especially grocery stores (as shown above) have remained an area of relative strength. Allowing more retail stores to operate (with restrictions) seems to have allowed for some recovery in the sector.

The other notable recent trend is that the health care sector saw a decline of roughly 10 percentage points from late March to mid-April, hitting a low of -61%. This coincided with announcements of furloughs as hospital systems in the state due to the decline in all non-essential visits and procedures. Again, health saw recovery over the past two weeks as a number of major medical centers announced the resumption of more services.

In addition to breaking out traffic by industry, the SafeGraph data allows me to separate trends across different locations. Figure 4 shows the relative trends for the two largest metropolitan areas in Wisconsin: Milwaukee and Madison. Both metro areas show very similar trends. The total traffic began to decline slightly earlier and fell slightly more in Madison, while restaurant traffic visits were very similar in both areas. The declines in total traffic were somewhat larger in these metro areas than in the state overall. The shutdown of UW-Madison and the absence of thousands of students drove an especially large decline in Madison, where traffic was down roughly 70% from late March through mid-April, before recovering slightly over the past two weeks.