Reopening Wisconsin: Regional Health and Economic Factors

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Executive Summary

- Most states have imposed stay-at-home orders to fight the COVID-19 pandemic. Now many are considering guidelines for reopening, which have been based solely on current health indicators. We consider both economic and health factors, accounting for differences across regions and industries.
- We estimate that the COVID-19 pandemic in Wisconsin is costing roughly $1.7 billion per week in lost economic activity. We estimate a 30% decline in output and a 13 percentage point increase in unemployment statewide through April 18, 2020.
- On average the counties which were in the worst economic condition prior to the pandemic have had the largest declines in economic activity.
- We estimate that the statewide Safer at Home order accounts for only 20% of the output decline, with the balance due to other mostly voluntary distancing measures.
- We also analyze health factors at a regional level. At least two of the state's Health Emergency Readiness Coalition (HERC) regions still face high health risks.
- At least three HERC regions have had very low rates of infections and positive tests for COVID-19, and may be close to satisfying the current health guidelines.
- However at least some counties within these regions face higher risks from infection due to a larger vulnerable population and lower health system capacity.
- We suggest that as policymakers consider reopening the economy, they move toward a phased-in regional relaxation of social distancing guidelines.

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1. Overview

As the COVID-19 pandemic spread across the globe, policymakers have imposed unprecedented interventions to slow the spread of the virus and mitigate its impact. These public health measures have led to massive economic disruptions. As the crisis has evolved, policymakers have proposed guidelines which would allow a loosening of the restrictions. However most of the current guidelines and discussion are based solely on current health indicators. While these are, of course, a primary consideration in the response to the pandemic, they are not the sole consideration. In this report we consider both economic and health factors, taking into account important differences across industries and regions. We provide a framework for considering these impacts.

We estimate that the COVID-19 pandemic in Wisconsin is costing roughly $1.7 billion per week in lost economic activity. We conservatively estimate a roughly 30% decline in output and 13 percentage point increase in unemployment across the state, with some regions being hit much harder. We also find that on average the regions which were in the worst economic condition prior to the pandemic have suffered the most. However we estimate that the statewide Safer at Home order limiting activity accounts for only 20% of the output decline, with the balance resulting from voluntary distancing measures.

Against these economic considerations we consider regional health impacts. While much of our analysis is done at the county level, for some health measures we follow the state Department of Health Services (DHS) and aggregate counties into Health Emergency Readiness Coalition (HERC) regions. At least two of the state's HERC regions still face high, and in some cases increasing, health risks. However we also find that at least three regions of the state have had very low rates of infections and positive tests for COVID-19, and may be close to satisfying the current health guidelines. However at least some counties within these regions face higher risks from infection due to a larger vulnerable population and lower health system capacity.

We suggest, that as policymakers consider reopening the economy, they move toward a phased-in regional relaxation of social distancing guidelines. This would allow for the state to continue to expand testing and tracing capacity, and monitoring for any outbreak, while at the same time allowing a gradual resumption of economic activity.

2. Background

The starting point of our approach is the current state and federal guidelines for reopening the economy, the national "Opening America Up Again" guidelines as well as the Wisconsin "Badger Bounce Back" plan.[1] These guidelines focus on current health indicators on the coronavirus infections and testing, as well as the health system capacity. To date they have been mostly applied at the state level. However statewide measures may be too blunt an instrument to deal effectively with the crisis in both urban and rural parts of the state, and to provide the appropriate balance between objectives. In

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[1] See https://www.whitehouse.gov/openingamerica/ and https://www.dhs.wisconsin.gov/publications/p02653a.pdf.

addition, the economic and health risks and tradeoffs differ substantially across locations: areas with older & less healthy populations face higher health risk, while richer populations with more telework jobs face lower economic risk. Further, we argue that when considering reopening the economy, we should move away from categorizing businesses as essential or non-essential. Instead we should focus on risk by occupation and industry. Some "non-essential" industries may be able to be reopened with relatively low health risk.

Our main contribution relative to all the previous reopening guidelines is to include measures of the economic impact of the crisis. When considering whether to maintain, loosen, or perhaps tighten restrictions on activity, the economic consequences of the actions should be considered along with the health impacts. Ultimately any reopening plan involves tradeoffs, balancing increased health risk that would come with the resumption of economic activity against the economic costs of lost jobs, incomes, and economic hardship associated with continued economic restrictions. In order to have a serious discussion of the tradeoffs, we must measure both costs and benefits. Previous approaches have focused solely on health factors.

We build on previous plans to reopen the economy, including the state and federal guidelines as well as the influential paper by Gottlieb et al. (2020).[2] We follow these guidelines in our current health indicators, however we apply them to a regional level, with weighting of the different indicators. That is, we seek to operationalize these guidelines quantitatively. We also recognize that regions differ in how they would be impacted by increased infections, with larger impacts in areas with larger vulnerable populations and lower health system capacity.

In pursuing a regional approach and considering industry risk, our approach is also related to the WMC plan.[3] However we consider broader health measures which more closely follow current state and federal health guidelines. Moreover, while the WMC plan envisions imminent statewide reopening with different levels of mitigation strategies, we consider the tradeoffs in re-opening by region, dependent on both health and economic factors. Nonetheless, the WMC plan includes many useful details for best practices for safety with mitigation, hygiene, and distancing for different types of businesses.

3. Methodology

As we discussed, restrictions, social distancing, and shutdown orders to slow the spread of the virus have had clear economic consequences. We consider two types of regional economic measures, which we implement at the county level:

- **A baseline economic index by county**. This index provides a measure of the county's economic situation prior to the COVID-19 crisis. This includes basic economic indicators such as median household income, poverty rate, unemployment rate, food security and FoodShare enrollment. The fraction of

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[2] https://www.aei.org/research-products/report/national-coronavirus-response-a-road-map-to-reopening/

[3] https://www.wmc.org/news/press-releases/wmc-announces-plan-to-get-back-to-business/

employment in a county that is amenable to telework, while less crucial prior to the crisis, has also helped determine how the county has been impacted.

- **A current economic index by county.** This captures, to the extent possible, how the county has been affected economically by the COVID-19 crisis. Given the delays in official reporting, this data is limited, and not all measures are available at a regional level. For now, we include initial unemployment claims and an estimate of economic activity from foot traffic data. We scale this index so it is interpretable as a percentage of lost output.

By separating the baseline and current economic indexes, we take into consideration that the same amount of economic loss due to the pandemic may have different consequences regionally. For example, a lower-income county having higher poverty rates and more food insecurity may be less able to weather losses in employment and income when compared to a more prosperous county.

A by-product of our economic measures is a statewide estimate of lost output due to the pandemic. We calculate this by aggregating reductions in economic activity by industry, adjusting for the shift to telework. However, this estimate is the total lost output due to the crisis, not just the losses due to the statewide Safer at Home order. In particular, substantial voluntary social distancing and declines in activity had taken place before the order was introduced as the virus spread. We discuss how we use the experience of other states to separate the impact of the Safer at Home order from voluntary social distancing.

Further, as we consider a planned reopening in stages, we seek to move beyond a classification of business as essential or non-essential. Instead, we provide a systematic approach to considering the safety of reopening the industry. Businesses in all industries should continue to encourage telework whenever possible, and all businesses should follow appropriate guidelines for social distancing, hygiene, and personal protective equipment. Nonetheless, industries differ in their ability to adapt to these guidelines. This leads to our measure of:

- **Industry risk**. In particular, for each broad industry, defined by a two-digit NAICS code or 4 digit Census code, we consider the degree of work in that industry that requires close proximity. Industries that require more work to be done in close proximity face a higher risk of spreading the virus, and thus require stronger mitigation efforts.

When we turn to health factors, we again break the analysis regionally into two components:

- **A baseline health index by county**. This score provides measures of the county's underlying health, risk factors, and susceptibility to the COVID-19 crisis. This includes basic health and demographic factors, such as population density, population over age 65, health system infrastructure, and prevalence of serious underlying health conditions in the local population.

- **A current health index by region.** This captures metrics that are being tracked in the current COVID-19 crisis and which govern existing reopening guidelines: number of COVID-19 cases, trends in new COVID-19 case diagnoses, trends in the fraction of positive tests, and health system capacity which includes ICU bed availability and PPE availability.

The health system data is reported by Health Emergency Readiness Coalition (HERC) region, so for current health we aggregate counties in to their HERC regions. This aggregation also helps smooth fluctuations in COVID-19 tests and cases, particularly for small counties.

By separating the baseline health score from the current health score, we take into account that coronavirus infections may have different regional health impacts. For example, an outbreak in a region with a relatively larger vulnerable population or less developed health system may be more damaging than in a region with a younger and healthier population.

Our approach for the baseline indexes is guided by the County Health Rankings produced by the Robert Wood Johnson Foundation.[4] As in those rankings, we combine a number of different indicators to give an overall sense of a region's condition, and some of our health measures follow theirs. But while they focus on a broad picture of overall health, we look at health factors specific to COVID-19, as well as economic indicators. Our methodology follows theirs: we standardize each indicator by county, transforming it to a z-score (subtracting the mean across counties and dividing by the standard deviation), so that each variable is on the same scale. Each variable is normalized as well so that a lower score is a better outcome. Then for each index we compute a weighted average of the z-scores. For ease of interpretation, we scale the composite index so it has mean 100 and standard deviation of 10. That is, the average county has a score of 100, with most counties in the 90-110 range. Counties with scores above 110 have exceptionally poor measures, while those below 90 are exceptionally good.

For the current economic and health indexes, we provide values which have a more direct interpretation. In particular, for the current health index we compute a weighted measure of new COVID-19 cases per day, while for the current economic index we compute a weighted estimate of lost income.

4. Economic Measures

4.1 Baseline Economic Index

This score provides measures of the county's economic situation prior to the COVID-19 crisis. This includes basic economic indicators such as median household income, poverty rate, unemployment rate, food insecurity rate, and FoodShare enrollment. The fraction of employment in a county that is amenable to telework, while less crucial prior to the crisis, is also an important pre-existing factor in how the county has been impacted by the pandemic. As discussed above, we convert each measure to a z-score and average

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[4] https://www.countyhealthrankings.org/

across variables to compute our baseline economic index. We weight each factor equally, apart from the two food measures whose sum gets equal weight with the other factors.

Table 1 reports the baseline economic index for the five highest and five lowest counties in the state, along with selected components of the index. The full baseline economic index by county is given in the appendix, and is depicted in Figure 1. Waukesha County, with its high median income, low poverty, and high degree of telework has the lowest baseline economic index at 72. Menominee County, with the lowest median income in the state and high degrees of poverty and food insecurity has the highest value at 135. Generally, the more rural northern parts of the state are poorer and thus have higher baseline economic index values.

County	INDEX	RANK	Median income	Poverty rate	Unemp rate	Food insecurity	Food share	Telework
Waukesha	71.92	1	78268	5.0	3.2	6.4	3.2	53.0
Ozaukee	72.33	2	78415	4.2	2.9	7.0	2.9	51.1
Washington	75.79	3	70325	4.5	3.3	6.8	4.1	51.1
Calumet	83.10	4	70042	5.3	3.3	6.5	3.8	39.8
St. Croix	83.37	5	73743	4.7	4.8	6.9	4.0	41.9
Iron	112.45	67	41270	13.2	7.3	12.1	11.6	38.1
Adams	112.56	68	43554	15.3	7.8	10.1	13.7	39.0
Rusk	112.81	70	39904	14.3	7.0	11.0	13.8	38.1
Sawyer	113.08	71	41869	14.5	7.3	12.0	11.4	38.1
Menominee	135.02	72	37147	26.5	6.6	17.2	33.7	34.2

Table 1: Baseline economic index and its components in highest and lowest five counties.

HERC Name	Index	HH Income	Poverty Rate	Food Insecurity	Telework
Northeast	95.07	52566	9.22	9.11	41.30
North Central	98.66	50214	9.99	9.53	39.55
Northwest	100.21	53794	10.83	9.75	38.62
Western	98.69	51240	11.37	10.19	40.09
South Central	91.78	58263	10.39	9.68	44.10
Fox Valley	92.83	56005	8.97	9.00	40.71
Southeast	96.39	57027	12.66	11.15	45.55

Table 2: Baseline economic index and its components by HERC region.

For comparison with some of our health measures below, we also aggregate the counties to their respective HERC region. That is, we compute a composite HERC index as a population-weighted average of the indexes of each member county. These are reported in Table 2. At the HERC region, there is much less variability in the Baseline Economic Index than at the county level. This is because the regional aggregation smooths the sharp difference across counties. For example, the Southeast Region contains Milwaukee (rank 66) as well as Waukesha, Ozaukee, and Washington (rank 1, 2, and 3). Thus while
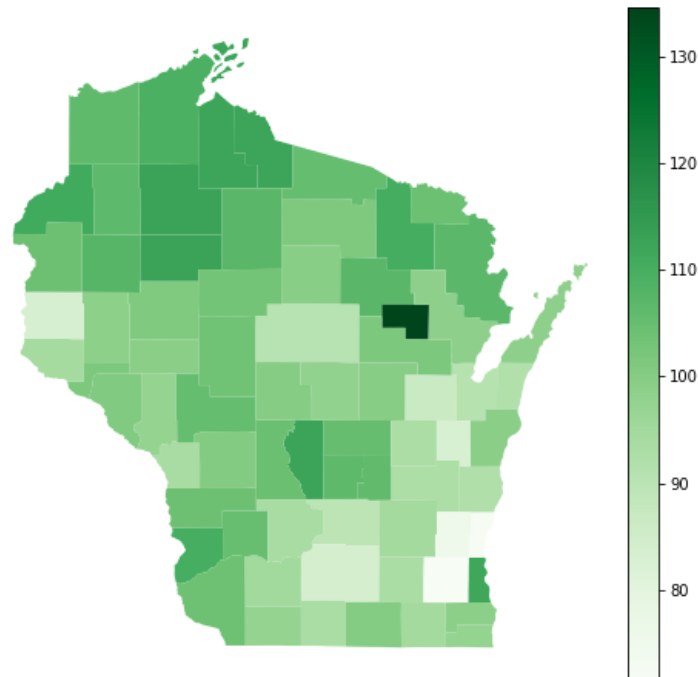
Figure 1: Baseline economic index by county.

considering the HERC region for health factors makes sense given the regional mobility in health systems and health capacity, economic impacts seem to be more localized.

4.2 Current Economic Index

Our current economic index captures, to the extent possible, how the county has been affected economically by the COVID-19 crisis. Given the delays in official reporting, this data is limited, and not all measures are available at a regional level. Thus we focus on two indicators: a measure of labor market activity, from initial unemployment claims at the county level, and an estimate of the decline in total economic activity from SafeGraph foot traffic data.[5] We weight these factors so that they are interpretable as a percentage reduction in output.

Other economic indicators would be useful and may be added in the future as we obtain more data. In other work, we have used statewide changes in consumer spending, but the regional coverage in this data is limited.[6] We would also like to include additional

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[5] SafeGraph is a data company that aggregates anonymized location data from numerous applications in order to provide insights about physical places. To enhance privacy, SafeGraph excludes census block group information if fewer than five devices visited an establishment in a month from a given group.
[6] https://crowe.wisc.edu/wp-content/uploads/sites/313/2020/04/consumption.pdf

indicators focused on lower-income households, who are most affected by economic downturns, but have been unable to obtain recent regional data. The state DHS publishes monthly county-level data on public assistance programs such as FoodShare caseload and Medicaid enrollment, but the most recent monthly data from March show no discernible impact (yet) from the pandemic.

Our first measure is the share of the labor force by county that has filed an initial unemployment claim from 3/15/20-4/18/20, the most recent data by county. Since recent hiring of new workers has been minimal in most industries and locations, the number of initial unemployment claims as a share of the county's labor force gives our estimate of the increase in the unemployment rate by county. State-level data released since 4/18/20 show that unemployment has continued to increase. An additional 48,000 initial applications, representing 1.6% of the statewide labor force, were filed in the following week.

Industry	NAICS	Telework	Activity Decline	Adjusted Decline
All Industries	--	0.380	-59.7	-37.0
Manufacturing	31-33	0.406	-62.3	-37.0
Wholesale Trade	42	0.660	-57.6	-19.6
Retail Trade	44-45	0.569	-44.8	-19.3
Information	51	0.665	-79.2	-26.5
Finance and Insurance	52	0.758	-45.4	-11.0
Real Estate Rental and Leasing	53	0.732	-58.8	-15.8
Educational Services	61	0.805	-89.1	-17.4
Health Care and Social Assistance	62	0.359	-61	-39.1
Arts, Entertainment, & Recreation	71	0.377	-72.6	-45.2
Accommodation and Food Services	72	0.256	-65.4	-48.7
Other Services (except PA)	81	0.256	-58.1	-43.2

Table 3: Declines in economic activity for select sectors in Wisconsin, adjusted for telework.

Our second measure is an estimate of the reduction in output by county. For this, we use economic activity measures from cellphone foot traffic provided by SafeGraph, which we regularly update.[7] While the underlying data captures economic activity at over 50,000 locations around the state, the geographic coverage is too sparse to provide accurate measures by county and industry. So instead we use our statewide estimates of year-over-year declines in activity by sector (for the week 4/12/20-4/18/20), which we adjust by the share of telework by industry to compute economic losses by sector. That is, we presume that some of the reduced current activity at work is now being done from home. The adjusted declines are listed in Table 3. Then, based on the sectoral concentration of GDP in each county, we compute the weighted-average GDP loss, using the 2018 GDP by county (the latest available). This measure inevitably misses regional variation in economic activity, as only the industry concentration varies by region. Nonetheless, it

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[7] https://crowe.wisc.edu/wp-content/uploads/sites/313/2020/04/activity-1.pdf

provides a reasonable estimate of how different parts of the state have been affected economically due to their differing industry exposure.

In Table 4, we report the current economic index and its components at the state level, as well as for the five highest and lowest counties. To calculate the index, we use the common Okun's law approximation that a 1% increase unemployment corresponds to a 2% fall in GDP, which we then average with our direct measure. This combination likely provides an underestimate of the total economic decline, as unemployment is still increasing throughout the state, and other estimates (based on in-store sales and reduction in hourly work) point toward a larger output decline. Our estimate suggests a 28% fall in GDP statewide, which is the average of the losses due to a 12.7 percentage point increase in unemployment (approximately equal to a 25.4% GDP decline) and a directly-estimated 29.8% decline in GDP. Moreover there are substantial losses across all counties, ranging from a low of 21.2% in Pepin County to a high of 33.8% in Menominee County.

County	INDEX	RANK	UI Claims (1000)	Labor Force (1000)	Unemp gain (%)	Avg Wage ($)	Lost Weekly Income ($M)	GDP Decline (%)	Lost Weekly GDP ($M)
Statewide	27.6	--	392.41	3096.89	12.7	930	364.94	29.8	1717.3
Pepin	21.2	1	0.25	4.01	6.2	744	0.18	30.0	1.4
Pierce	21.3	2	1.55	25.40	6.1	666	1.03	30.4	5.2
Taylor	21.8	3	0.68	10.90	6.3	743	0.51	31.1	4.8
Lafayette	22.0	4	0.67	9.99	6.7	694	0.46	30.6	3.2
Dane	22.5	5	29.39	323.27	9.1	1053	30.95	26.7	197.5
Jackson	31.5	68	1.52	10.04	15.2	827	1.26	32.6	5.2
Forest	32.1	69	0.73	3.96	18.5	557	0.41	27.3	1.0
Trempealeau	32.4	70	2.46	15.74	15.6	817	2.01	33.5	8.6
St. Croix	32.4	71	5.55	34.79	16.0	757	4.20	32.9	21.3
Menominee	33.8	72	0.30	1.55	19.1	296	0.09	29.3	0.3

Table 4: Current economic index and its components statewide and in the five highest and lowest counties in Wisconsin.

The fact that Menominee County, the poorest county in the state, has suffered the largest losses is consistent with the broader picture. That is, as shown in Figure 2, on average counties which were in the worst economic position before the pandemic (as measured by our baseline economic index) have fared the worst during the crisis. Low income individuals typically suffer the most in an economic downturn, and the same holds true when aggregated to county level. This is particularly the case for the current broad-based economic downturn, which has hit all geographical areas and has been especially strong in lower-wage sectors like food & beverage and retail.

We also provide two measures of lost income to get a sense of the overall magnitude of losses statewide and by county. The measure of lost labor income from unemployment is
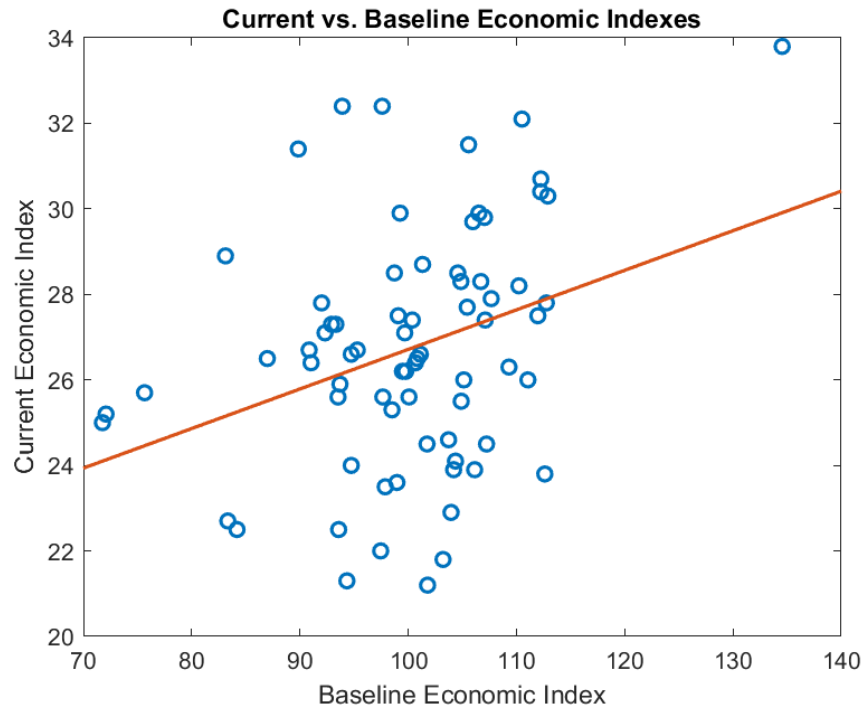
Figure 2: Baseline economic index vs. current economic index.

calculated as the average weekly wage, from 2019:Q2, multiplied by the number of initial unemployment applications. The lost GDP is the calculated from 2018 GDP by county, converted to a weekly measure. Thus we see that statewide losses total $365 million per week in lost labor income from unemployment, and $1.7 billion per week in lost output. Clearly given the smaller populations, the total dollar losses are smaller in most counties, but Dane county for example is seeing an output loss of $197.5 million per week.

5. Impact of the Safer at Home Order

In the previous section we focused on quantifying the economic impact of the COVID-19 pandemic on the state of Wisconsin. However a separate but important question is the impact of the Safer at Home order issued by the Governor. Before the order was issued, as the virus spread, many businesses had already imposed social distancing guidelines, workers had begun working remotely, and consumers had changed their purchasing behavior. Thus a substantial portion of the economic impact reflects voluntary responses to the spread of the virus. If the Safer at Home order were rescinded, it is unlikely that substantial economic activity would resume until consumers, workers, and businesses were confident that their risk of contracting the virus had diminished. In this section we estimate the impact of the Safer at Home order on behavior, and use these results to estimate the impact of the order on economic activity.

The impacts of stay-at-home orders on both the spread of COVID-19 and the economy depend on how effective they are in limiting the mobility of Americans, which is a question without an obvious answer. Partly because these orders are not strictly enforced, not everyone is taking them seriously, as suggested by many media reports
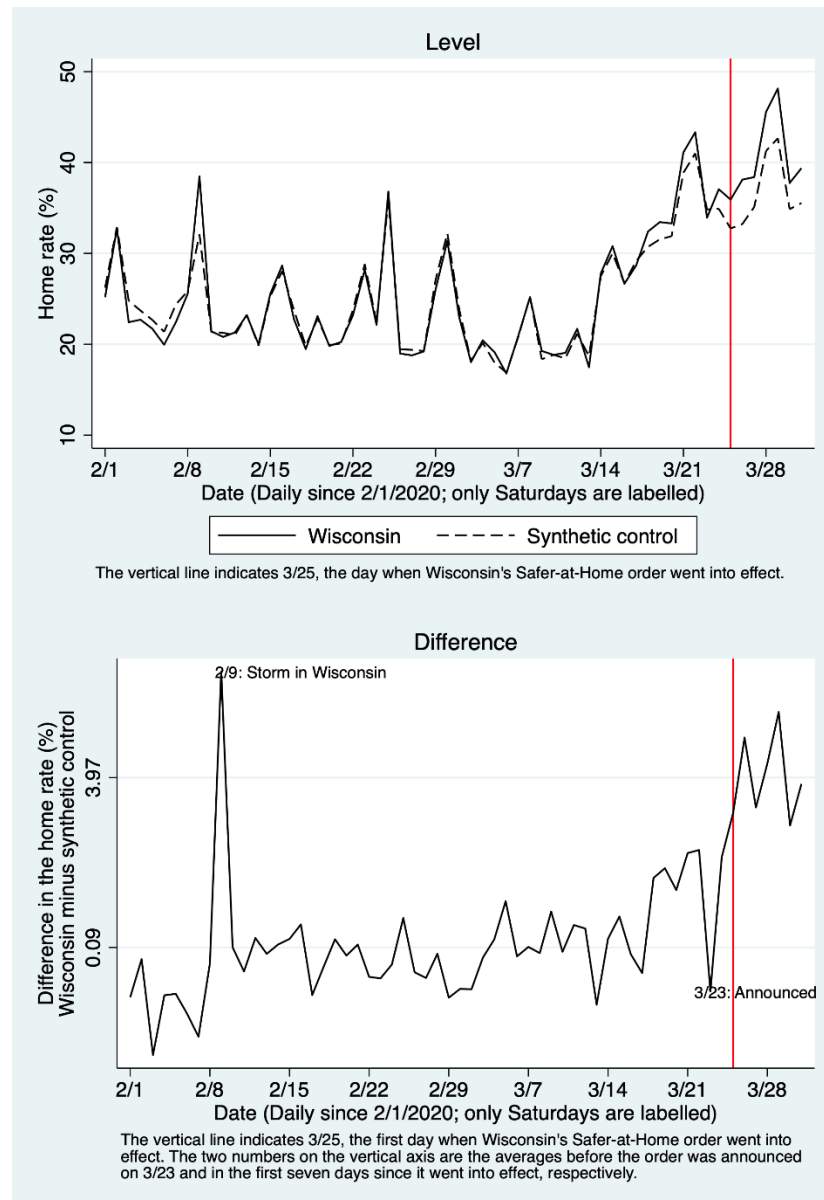
Figure 3: Daily home rate in Wisconsin and the synthetic control (top panel), and their difference (bottom panel).

about people ignoring the orders and leaving home unnecessarily. Moreover, as these orders were issued when COVID-19 was already widespread and were preceded by other social distancing guidelines, it is likely that many Americans had already chosen to stay home as much as possible by the time these orders were issued, leaving little room for them to have a large impact. Finally, even if we observe a change in mobility after an order went into effect, it is possible that part of the change is a voluntary response to the continuing spread of COVID-19 instead of a direct impact of the order.

In current work we are estimating the impacts of statewide stay-at-home orders on the mobility of Americans using GPS data from mobile devices (almost all of which are cellphones). Again we use data from SafeGraph for this analysis. Specifically, we use a

daily measure of the percentage of mobile devices without a GPS ping observed from outside their home location as a proxy for the fraction of Americans at home all day. We focus on this rather extreme notion of social distancing here, but obtain similar results when looking at other mobility measures.

In order to estimate the impact of the Safer at Home order, we use the method of synthetic controls. Specifically, to estimate the impact of the Safer-at-Home order in Wisconsin during the first 7 days (March 25-31) it was in effect, we use the 15 states without a stay-at-home order announced by March 31 as potential controls. We then select the weights for these states such that the resulting synthetic control matches Wisconsin as close as possible before March 23, in terms of both the home rate and other predictors including the number of confirmed cases of COVID-19. The differences in the home rate between Wisconsin and the synthetic control in the period of March 25-31 are interpreted as the impact of the order in the first seven days.

Our synthetic control estimation approach is illustrated in Figure 3. The top panel shows the daily home rate in Wisconsin and its synthetic control. The two rates are very close to each other until around the time when the order was announced and then went into effect, at which time the difference (shown in the bottom panel) increases noticeably.

On average, we find the difference is about 4 percentage points. That is, Wisconsin's Safer at Home order is associated with an increase of 4 percentage points in the fraction of Wisconsinites at home all day. We have done similar estimation for other states, finding that the impact of the order in Wisconsin is in line with other Midwestern states. In particular, the impact of the stay-at-home order in Wisconsin is very similar to that in Illinois, slightly stronger than in Indiana, and less severe than in Michigan.

Thus we find that the Safer at Home order has had a significant impact on behavior, but most of the response was voluntary. In particular, the top panel of Figure 3 shows that the home rate increased by 20 percentage points from March 10 to March 31. We estimate that the Safer at Home order accounted for 4 percentage points, or 20%, of this total change. Thus while in the previous section we estimated that the pandemic led to a decline of roughly 30% of GDP and a loss of $1.7 billion per week, we estimate that the Safer at Home order accounts for a 6% GDP decline and a loss of $343 million per week.

Of course against these economic losses from the Safer at Home order, we must consider the beneficial health impacts from slowing the spread of the virus and mitigating its impact on the health system. The health impacts, which we turn to later, have been the focus of most attention. But first we discuss the risk associated with different industries.

6. Industry Differences

While we mostly focus on economic and health impacts by region, there are also substantial differences in risk across industries. As policymakers consider a planned reopening in stages, they should move beyond classifying business as essential or non-essential. We provide a measure of the safety of reopening industries according to their work proximity. Policymakers may look to first relax restrictions on industries that

require less work to be done in close proximity, and thus present lower risk for spread of the virus.

code	NAICS Description	score	code	Census Description	score
54	Professional, Scientific, and Technical Services	51.1	280	Fishing, hunting and trapping	47.4
52	Finance and Insurance	51.8	270	Logging	48.6
55	Management of companies and enterprises	52.6	7690	Services to buildings and dwellings	48.9
11	Agriculture, Forestry, Fishing, and Hunting	53.0	7380	Computer systems design	49.1
32	Manufacturing	54.0	7370	Specialized design services	49.4
42	Wholesale Trade	54.1	7270	Legal services	49.7
33	Manufacturing	54.3	6490	Software publishers	49.9
39	Manufacturing	54.6	9380	Public finance activities	50.2
51	Information	54.8	7280	Accounting, tax preparation	50.2
56	Administrative and support	55.4	6970	Securities and financial investments	50.3
53	Real Estate and Rental and Leasing	55.8	7460	Scientific research and development services	50.6
31	Manufacturing	56.2	7390	Management, scientific, and consulting services	50.7
49	Transportation and Warehousing	56.6	7290	Architectural, engineering, and related services	50.7
22	Utilities	56.9	6870	Banking and related activities	50.8
45	Retail Trade	58.9	…		…
92	Public Administration	59.6	8192	Psychiatric and substance abuse hospitals	73.1
21	Mining, Quarrying, and Oil and Gas Extraction	59.7	8290	Residential care facilities	73.3
44	Retail Trade	61.4	8470	Child day care services	73.3
46	Retail Trade	62.0	8690	Drinking places, alcoholic beverages	73.6
71	Arts, Entertainment, and Recreation	63.1	7980	Offices of dentists	73.7
81	Other Services, Except Public Administration	63.6	7480	Veterinary services	74.8
23	Construction	64.0	8191	General medical & surgical hospitals	75.8
61	Educational Services	65.3	8270	Nursing care facilities	78.4
48	Transportation and Warehousing	65.7	8990	Nail salons, personal care services	82.9
72	Accommodation and Food Services	67.0	8170	Home health care services	83.9
62	Health Care and Social Assistance	74.5	8980	Beauty salons	89.4
			8970	Barber shops	91.2

Table 5: Proximity by 2-digit NAICS industry, as well as highest and lowest by 4-digit Census industry.

For each broad industry (defined by a two-digit NAICS code or four-digit Census code), we construct an employment-weighted proximity measure using data from O*NET.[8] In particular, O*NET classifies occupations according to the question, "To what extent does this job require the worker to perform job tasks in close physical proximity to other people?" The 967 different occupations are scaled from 0 (beyond 100 ft.) to 100 (very close, near touching). For example, physical therapists score a 100 while fallers in the timber industry score a 7. We aggregate these occupation measures into average measures by industry using the employment share of each occupation in the industry.

The results are given in Table 5, which reports the proximity measure for each two-digit NAICS industry as well as a group of the highest and lowest values by four-digit Census industry. There we see that there is substantial variation in proximity across industries. Broadly speaking, professional services and manufacturing score relatively low, while health care, personal services, and food service score relatively high. Some businesses in these industries are currently in operation, at least to some degree, as essential businesses. However the proximity measures suggest that a phased re-opening could begin, to the extent that these activities cannot be done remotely, with professional services, finance, and manufacturing, among others. Health services, personal services, food services, and child care, among others will require special attention and guidelines.

7. Health Measures
7.1 Baseline Health Index

For the baseline health index we include measures of the vulnerable population, which the national guidelines define as:

1. Elderly individuals (which we take to mean age 65 or older)
2. Individuals with serious underlying health conditions, including high blood pressure, chronic lung disease, diabetes, obesity, asthma, and those whose immune system is compromised such as by chemotherapy for cancer and other conditions requiring such therapy.

Thus we consider a subset of measures to capture the size of the vulnerable population: share of population over 65, percentage of adults with diabetes, percentage of adults who are obese, cancer incidence, and percentage of adults who are current smokers (a proxy for lung and respiratory problems). Data on hypertension, asthma, and lung disease were not available at the county level.

In addition, we include baseline measures which capture the health system capacity: the ratio of population to primary care physicians, and the total number of hospital beds and ICU beds per 1,000 population. For the hospital bed measures, we use data reported by HERC region, and we give each county in the HERC the same value. We also include a measure of the risk of the spread of the virus, population density. For our baseline index,

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[8] https://www.onetonline.org/find/descriptor/result/4.C.2.a.3

we give equal weight to each sub-category: health factors, age, health sector, and population density.

In Table 6 we list the baseline health index and selected components for the top and bottom five counties in the state. In the Appendix we provide the full county list. Dane County, driven by its younger and healthier population has the lowest index at 82, while Milwaukee County, due mostly to its population density has the largest, by some margin, at nearly 144. The baseline health index is shown in Figure 4. There is general strength in the south and west of the state, but worse baseline health in most of the northern counties.

County	INDEX	RANK	Obesity	Diabetes	Cancer	Smoking	65+	ICU	Density
Dane	82.24	1	22.6	6.1	452	12.4	11.9	0.23	408
La Crosse	83.43	2	27.2	6.6	439	14.8	14.7	0.12	254
Pierce	84.38	3	27.0	5.5	319	15.0	12.6	0.13	72
Portage	85.58	4	31.5	6.3	403	15.6	14.6	0.27	87
Jackson	87.59	5	33.2	4.1	402	17.9	17.6	0.12	21
Marquette	114.78	68	37.9	18.9	484	15.5	22.4	0.23	34
Vilas	117.74	69	31.2	12.3	563	17.2	28.8	0.27	25
Adams	119.17	70	30.2	17.4	494	16.4	27.0	0.23	32
Burnett	120.91	71	35.1	13.8	458	16.1	26.3	0.13	19
Milwaukee	143.97	72	32.2	10.4	499	17.8	12.2	0.29	3926

Table 6: Baseline health index and selected components by in top and bottom five counties.

HERC Name	Index	Pop % Over 65	Pop Density	ICU beds per 1000
Northeast	93.59	16.37	292.20	0.41
North Central	94.95	18.48	63.30	0.27
Northwest	98.89	16.43	74.99	0.13
Western	89.27	16.35	130.20	0.12
South Central	91.17	14.56	242.25	0.23
Fox Valley	101.82	15.43	241.36	0.16
Southeast	115.96	14.13	1943.01	0.29

Table 7: Baseline health index and selected components by HERC region.

For comparison with the current health index below, we also report the aggregation to HERC regions in Table 7. That is, we compute a composite HERC index as a population-weighted average of the indexes of each member county. The Southeast region has the highest index, driven largely by Milwaukee County. Fox Valley's index is slightly above average, but most of the rest of the regions are lower.
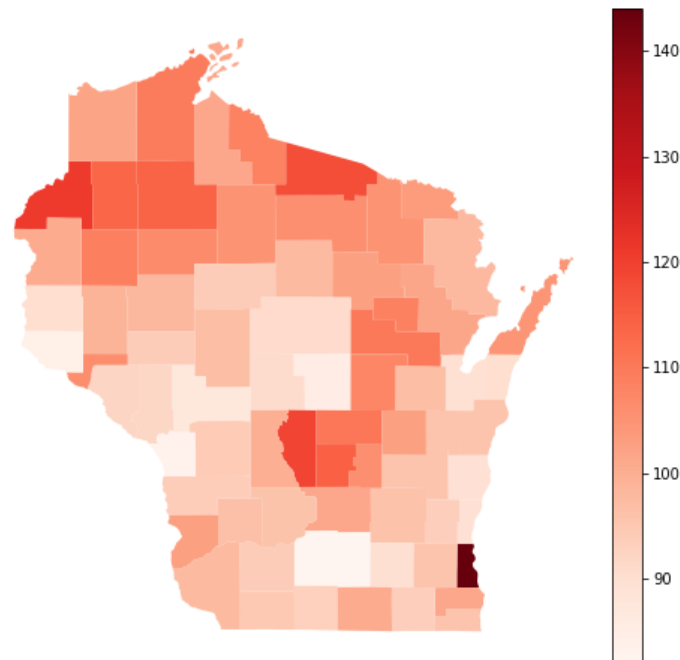
Figure 4: Baseline health index by county.

7.2 Current Health Index

As discussed above, our current health index captures many of the metrics from both the national "Opening America Up Again" guidelines as well as the Wisconsin "Badger Bounce Back" plan. These include 14-day trends in new COVID-19 case diagnoses, 14-day trends in the fraction of positive tests, and hospital capacity including immediate hospital bed availability and PPE availability. However rather than analyzing these metrics at the state level, we look at them regionally. The state health capacity data is published by HERC region, so we group counties into regions for this measure.

Both the federal and state guidelines also consider trends in influenza-like illness (ILI) reports, which provide a useful warning signal for infections. However these reports are less useful in the current situation in Wisconsin, as the statewide peak in ILI reporting by the CDC came four weeks ago (week 12 of the ILI reports, 3/21/20), with each following week declining up until the latest week 16 value   Moreover, in the latest statewide DHS report from week 14 (4/5/20), each region's reported ILI value was down from its peak. Given the statewide trends from the CDC, these regional trends likely remained lower. The ILI reports will be important to monitor for increases as advance warnings of infections if and when distancing restrictions are eased, but the condition for a downward trend in ILI reports in the reopening guidelines seems to have been met.

Additional important factors in the ability to address the COVID pandemic include testing for the virus and contract tracing. While it is crucial to develop these capacities to effectively respond to the crisis, these are state-level matters without clear regional metrics. Moreover, recent reports and guidance from state health officials suggest that the testing capacity is expanding and will be more widely available in the near term. For example, Governor Evers had pointed toward a goal of 85,000 tests per week, and the statewide lab capacity is now at nearly 11,000 tests per day and growing. However even though health officials are now recommending tests for anyone with symptoms, actual testing has been far below capacity, perhaps due to shortages of testing materials. Further, availability of ventilators is another crucial factor in medical capacity, but to date there has been sufficient excess supply at both the state and national levels. If either of these trends were to change, these factors would have to be monitored as well.

The key current health indicators are shown in Table 8, using data through 4/25/20. For each HERC, we list the total cumulative cases per 100,000 population, the 7-day average of new cases per day per 100,000 as well as the change in this value from one and two weeks ago, the 7-day average of the rate of positive tests as well as the change in this value from one and two weeks ago, the percentage of hospitals reporting less than 7 days of PPE availability (taken as the max of reports of N95 masks, shields, gowns, and paper masks shortages), the percentage of hospital beds immediately available, and the percentage of ICU beds immediately available.

Data through 4/25/20

HERC Name	INDEX	Cases per 100K	New Cases per 100K	2 week change	1 week change	Pos. Test Rate	2 week change	1 week change	PPE Avail	Bed Avail	ICU Bed Avail
Northeast	27.13	163.26	16.06	14.59	11.26	34.49	27.06	13.16	20.0	35.5	31.05
North Central	0.17	11.97	0.18	-0.09	-0.18	1.24	-1.03	-1.89	57.1	37.7	26.56
Northwest	0.00	18.42	0.15	-0.40	-0.31	0.41	-0.90	-0.85	53.8	40.9	28.38
Western	0.12	22.70	0.15	-0.37	-0.06	0.62	-1.68	-0.37	40.0	28.1	29.41
South Central	6.64	64.27	5.16	0.98	2.56	5.06	-0.31	0.86	28.1	38.4	30.22
Fox Valley	0.92	21.59	0.82	0.09	0.18	3.10	0.24	0.31	7.7	37.2	20.45
Southeast	25.33	169.64	22.90	-2.99	1.86	11.71	-4.09	-3.71	40.4	29.9	30.83

Table 8: Current health index and its components by HERC region.

While the previous guidelines have emphasized these key factors, they have not discussed how to operationalize or weigh them, suggesting that each component must be satisfactorily addressed. That is, the minimum performance across measures may be what matters. We list each element so that readers can evaluate the components.

We see that four of the HERC regions (North Central, Northwest, Western, and Fox Valley) have very low infection rates, new case rates, and positive test rates. Moreover the cases and positive test rates have been trending down for at least three of the regions, with Fox Valley seeing slight relative increases. However a majority of the hospitals in North Central and Northwest regions are reporting less than a week of PPE supplies.

Two HERC regions, Northeast and Southeast, have much higher infection and positive test rates. The Northeast region also has seen substantial increases in infections and positive tests, stemming from the outbreak in Brown County. Although the infection and positive test rates remain high in the Southeast region, the test rate is trending down while the infection rate increased over the past week after trending down (perhaps at least partially due to more testing).

To summarize these variables, we compute an index which is interpretable as a weighted trend in new cases. That is, we scale the 7 day average of new COVID cases by a factor that takes into account the trends in new cases and positive tests as well as health system capacity.[9] This index scales up the new case average if there is a positive trend in cases or test rates, as well as if there are PPE shortages at more than 40% of hospitals or fewer than 30% of ICU beds available. The index results align with our discussion: three regions are very low, two are high, Fox Valley is relatively low, and South Central is somewhere in the middle.

Depending on PPE availability, the North Central, Northwest, and Western regions may be close to satisfying the current health guidelines, if they have not already been met.

8. Using the Indexes

Now that we have presented our approach, we walk through how our indexes and calculations can be used to evaluate the tradeoffs associated with loosening or tightening restrictions on economic activity.

All of our indexes are normalized so that lower values represent better performance. First we begin with the health indexes. Recall that they have the interpretation:

1. Current health index: what regions are best positioned to lessen restrictions
2. Baseline health index: what regions face most consequences from infections

We combine the factors by multiplying the current index by the baseline health index (divided by 100), which gives a capacity-weighted measure of trend cases. Clearly alternative weighting approaches, for example giving a larger weight to the baseline or ignoring it altogether, would change analysis.

For example, the North Central Region has a baseline health index of 94.95 and a current health index of 0.17, which combined gives a scaled total health index of 0.16. This suggests that current health risk is low and baseline health capacity is high. By comparison the Southeast region has indexes of 115.96 baseline and 25.33 current, which combined give a total index of 29.37. This suggests that current risk remains elevated and the region's health capacity is lower.

Neither of these calculations substantially change what would result from just considering current health alone, although calculations at the county level do give more

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[9] In particular, we use the formula: (New cases+ (one week change)/2)*(1+(one week change in test rates)/100)*(1+MAX(PPE-40,0)/20)*(1+MAX(ICU-30,0)/10).

variability. For example, Iron County in the North Central Region has a baseline index of 108.4. This suggests that although current health risk is low in the region as a whole, an outbreak would be more damaging to that county in particular, so the total health index increases to 0.18. Giving the baseline more weight in the combination would boost the value more.

Similarly, the economic indexes have the following interpretation:

1. Current economic index: what regions have lost the most in the pandemic
2. Baseline economic index: what regions are most able to weather downturn

To continue the examples, we select one county from the North Central Region. Iron County has a baseline economic index of 112.25, reflecting its status as one of the poorer counties in the state. Its current economic index is 30.7, reflecting a 12.5 percentage point increase in unemployment and an estimated 36% decline in GDP. Combining gives a total economic index of 34.5. Thus when considering to ease restrictions on this county, policymakers must weigh an infection rate of roughly 0.2 new daily cases per 100,000 residents against a cost of 6% (20% of 30) in lost output.

For Brown County, the center of the recent COVID-19 outbreak, the considerations would be different. The current health index is 27.1, reflecting a high and increasing infection rate. Even though Brown has a good baseline health index of 90, this still results in a scaled rate of 24 new cases per day per 100,000 residents. Against this would be factored a total economic index of 24 (26.4 current, 91 baseline). That is, for Brown County policymakers must weigh an effective infection rate of 24 new cases per day per 100,000 residents against a loss of 4.8% (20% of 24) of output.

9. Conclusion

In considering how to adapt to the coronavirus, the economic and health tradeoffs are unavoidable. The social distancing measures taken so far have slowed the spread of the virus and mitigated its damage, but have come with severe economic costs. We have provided a framework for evaluating these tradeoffs, taking into account the regional differences in both health and economic factors. Whatever weights policymakers place on these factors, an approach which recognizes these regional variations seems crucial.

We suggest that as policymakers consider reopening the economy, they move toward a phased-in regional relaxation of social distancing guidelines. This would allow for the continued monitoring and mitigation of health risk, while building toward the gradual resumption of economic activity.

Appendix: Economic and Health Indexes by County

County	Baseline Health INDEX	Base Health RANK	HERC Name	Current Health INDEX	Health Rank (HERC)	Baseline Econ INDEX	Base Econ RANK	Current Econ INDEX	Current Econ RANK
Adams	119.17	70	South Central	6.64	5	112.62	69	23.8	11
Ashland	101.39	43	Northwest	0.00	1	112.24	67	30.4	65
Barron	108.88	62	Northwest	0.00	1	107.67	61	27.9	52
Bayfield	109.53	63	Northwest	0.00	1	109.31	62	26.3	32
Brown	89.87	8	Northeast	27.13	7	91.03	10	26.4	33
Buffalo	92.36	15	Western	0.12	2	100.84	38	26.5	35
Burnett	120.91	71	Northwest	0.00	1	111.06	65	26.0	29
Calumet	95.77	25	Fox Valley	0.92	4	83.12	4	28.9	59
Chippewa	98.32	38	Northwest	0.00	1	101.12	39	26.6	37
Clark	97.02	33	North Central	0.17	3	103.73	44	24.6	18
Columbia	101.43	45	South Central	6.64	5	89.85	8	31.4	67
Crawford	102.78	48	Western	0.12	2	110.23	63	28.2	53
Dane	82.24	1	South Central	6.64	5	84.19	6	22.5	5
Dodge	96.36	31	South Central	6.64	5	94.74	20	26.6	38
Door	104.74	52	Northeast	27.13	7	98.73	28	28.5	57
Douglas	102.06	47	Northwest	0.00	1	106.14	55	23.9	13
Dunn	98.95	39	Northwest	0.00	1	98.96	29	23.6	10
Eau Claire	94.17	20	Northwest	0.00	1	99.47	32	26.2	30
Florence	103.70	51	Northeast	27.13	7	104.58	48	28.5	56
Fond du Lac	95.89	28	Southeast	25.33	6	92.92	13	27.3	43
Forest	105.25	53	North Central	0.17	3	110.51	64	32.1	69
Grant	97.76	35	South Central	6.64	5	103.96	45	22.9	8
Green	93.29	16	South Central	6.64	5	93.58	16	22.5	6
Green Lake	106.11	56	Fox Valley	0.92	4	105.97	54	29.7	60
Iowa	94.17	21	South Central	6.64	5	95.30	22	26.7	40
Iron	108.42	60	North Central	0.17	3	112.25	68	30.7	66
Jackson	87.59	5	Western	0.12	2	105.58	53	31.5	68
Jefferson	90.09	9	South Central	6.64	5	93.52	15	25.6	24
Juneau	100.06	40	South Central	6.64	5	104.87	49	28.3	54
Kenosha	95.82	26	Southeast	25.33	6	97.66	25	25.6	23
Kewaunee	90.36	11	Northeast	27.13	7	92.00	11	27.8	51
La Crosse	83.43	2	Western	0.12	2	93.70	17	25.9	27
Lafayette	94.92	24	South Central	6.64	5	97.46	23	22.0	4
Langlade	102.78	49	North Central	0.17	3	107.24	60	24.5	16
Lincoln	97.91	36	North Central	0.17	3	99.68	33	27.1	42
Manitowoc	95.87	27	Northeast	27.13	7	99.25	31	29.9	62
Marathon	91.11	13	North Central	0.17	3	90.85	9	26.7	39
Marinette	97.98	37	Northeast	27.13	7	107.05	58	29.8	61

County								
Marquette	114.78	68	South Central	6.64	5	106.53	56	29.9	63
Menominee	108.67	61	Fox Valley	0.92	4	134.55	72	33.8	72
Milwaukee	143.97	72	Southeast	25.33	6	111.98	66	27.5	48
Monroe	94.52	23	Western	0.12	2	100.67	37	26.4	34
Oconto	101.70	46	Northeast	27.13	7	98.50	27	25.3	21
Oneida	105.90	55	North Central	0.17	3	101.33	40	28.7	58
Outagamie	97.08	34	Fox Valley	0.92	4	86.99	7	26.5	36
Ozaukee	89.48	6	Southeast	25.33	6	72.09	2	25.2	20
Pepin	106.16	57	Northwest	0.00	1	101.79	42	21.2	1
Pierce	84.38	3	Northwest	0.00	1	94.34	19	21.3	2
Polk	100.74	42	Northwest	0.00	1	104.37	47	24.1	15
Portage	85.58	4	North Central	0.17	3	97.88	26	23.5	9
Price	105.26	54	North Central	0.17	3	107.11	59	27.4	45
Racine	101.41	44	Southeast	25.33	6	99.08	30	27.5	47
Richland	96.84	32	South Central	6.64	5	104.90	50	25.5	22
Rock	100.71	41	South Central	6.64	5	100.38	36	27.4	46
Rusk	106.65	58	Northwest	0.00	1	112.76	70	27.8	50
St. Croix	90.27	10	South Central	6.64	5	83.34	5	22.7	7
Sauk	96.15	30	Northwest	0.00	1	93.91	18	32.4	71
Sawyer	114.23	67	Fox Valley	0.92	4	112.90	71	30.3	64
Shawano	110.28	64	Southeast	25.33	6	101.74	41	24.5	17
Sheboygan	89.62	7	Northwest	0.00	1	92.32	12	27.1	41
Taylor	94.28	22	North Central	0.17	3	103.22	43	21.8	3
Trempealeau	92.02	14	Western	0.12	2	97.60	24	32.4	70
Vernon	93.85	19	Western	0.12	2	104.20	46	23.9	12
Vilas	117.74	69	North Central	0.17	3	105.45	52	27.7	49
Walworth	93.81	18	Southeast	25.33	6	94.74	21	24.0	14
Washburn	113.71	66	Northwest	0.00	1	106.71	57	28.3	55
Washington	93.81	17	Southeast	25.33	6	75.65	3	25.7	26
Waukesha	95.94	29	Southeast	25.33	6	71.76	1	25.0	19
Waupaca	107.66	59	Fox Valley	0.92	4	99.77	34	26.2	31
Waushara	110.56	65	Fox Valley	0.92	4	105.14	51	26.0	28
Winnebago	102.92	50	Fox Valley	0.92	4	93.32	14	27.3	44
Wood	90.85	12	North Central	0.17	3	100.07	35	25.6	25