This presentation premiered at WaterSmart Innovations

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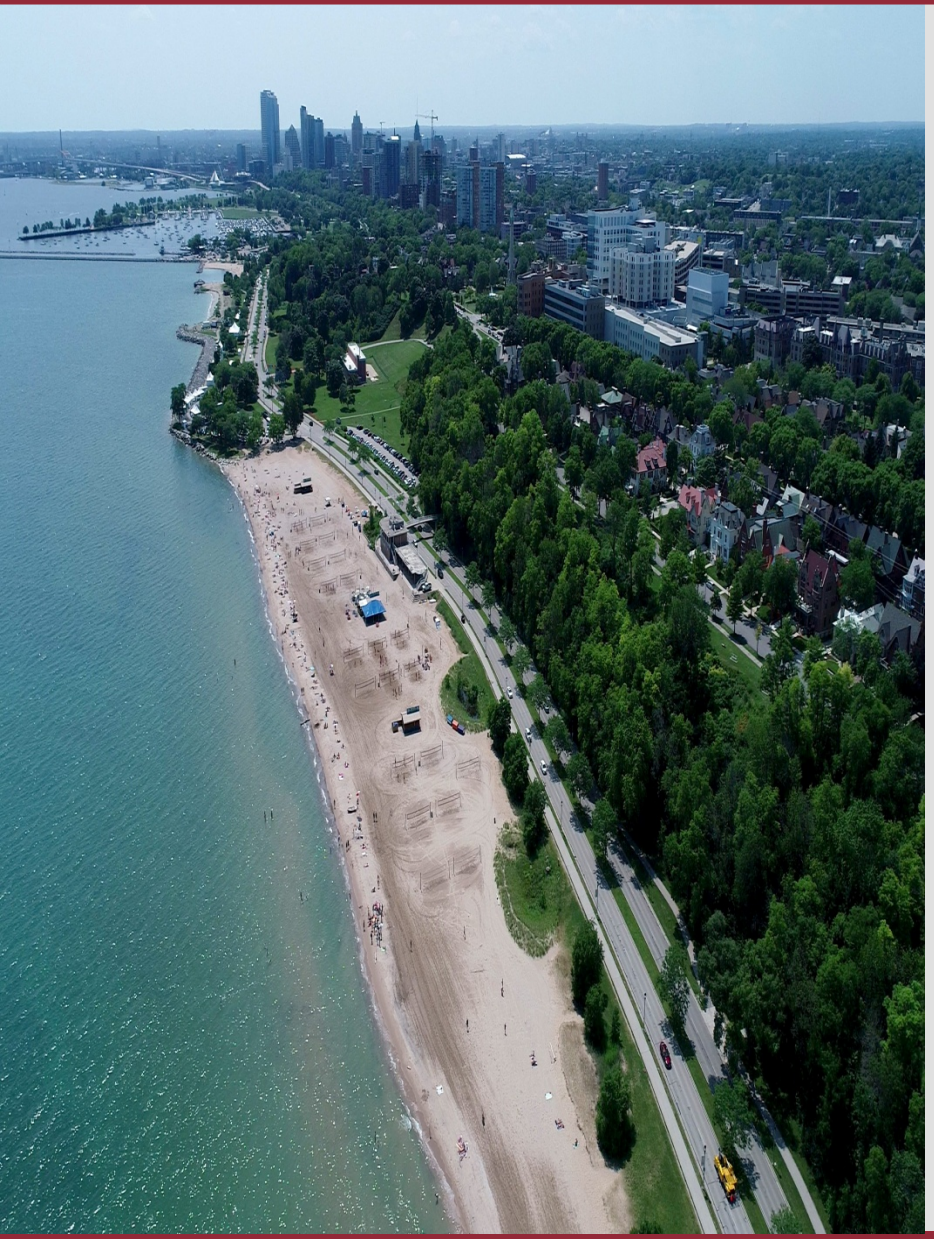
Financial Implications of COVID-19 for Public Water Systems in Wisconsin

Francesca Sanchez

James I. Price

University of Wisconsin-Milwaukee, School of Freshwater Sciences
Milwaukee, Wisconsin 53204

Email: priceji@uwm.edu, sanch237@uwm.edu



Background

- COVID-19 rapidly spread across the globe, causing not only illness, but also abrupt disruptions
  - Federal and local orders issued in response which greatly restricted business operations and movements of residents
- Restrictions led to unintended consequences for local businesses and industries
  - The water industry was one of the many impacted industries during the pandemic
  - Water usage levels changed as a response to people having to adapt their daily life, work, and travel habits to the closure of businesses, schools, and other institutions

Bradford Beach and Lake Michigan lakefront.
Mike De Sisti and Jim Nelson-Milwaukee Journal Sentinel

Existing Studies

- Cooley et al. (2020)
  - Changes in demand have affected utility expenditures and revenue
  - Effects depended on portion of residential and nonresidential water uses
- Eastman et al. (2020)
  - Residential consumption increased, non-residential decreased
- Li et al. (2020)
  - Residential water usage increased
  - Changes in water use also depended on weather and seasonality
- Nemati (2020)
  - Increases in residential use and decreases in nonresidential use
    - Peaked around the shelter-in-place order in California (3/19/20-5/8/20)
  - Effect on total water usage dependent on relative proportion of residential and nonresidential

Existing Studies

- Abu-Bakar et al. (2021)
  - Certain regions in the UK saw a 35% increase in peak daily consumption during lockdown
- Lüdtke et al. (2021)
  - Increase in water consumption coincided with restrictions and subsequent changes in work-life routines
  - Questions of water utility resiliency and whether COVID changes will persist

"Water Faucet" by Jenn Durfey is licensed under CC BY 2.0

Data Sources

- Public Service Commission of Wisconsin
  - Municipal Annual Report Data from over 500 utilities over a four-year span (2016-2020) was used
  - Regulatory agency that regulates municipal and investor-owned electricity, natural gas, water, and combined water and sewer utilities throughout the state
  - Establishes and approves rates through rate-setting process modeled from the American Water Works Association's cost-based rate-setting methods
    - Rate-setting process helps ensure that fair and adequate prices are being charged in the absence of competition, stable revenues are provided, rate shock is avoided, and wasteful use is discouraged

Methods

- Paired t tests were used to evaluate differences in average water use between consecutive years
  - Total water use: Residential, commercial, industrial, other
  - Per customer water use: Residential, commercial, industrial
- Fixed-effect panel regression were employed to evaluate differences in revenue and in the ratio of revenue to costs
  - Controls for time-invariant characteristics of water utilities
  - Controls for time-variant factors that affect revenue

Empirical Model

- Model for total revenue

$$\ln(r_{it}) = ln(c_{it})\beta_1 + ln(f_{it})\beta_2 + ln(m_{it})\beta_3 + \ln(p_{it})\,\beta_4 + Y20_{it}\,\beta_5 + \nu_i + \varepsilon_{it}$$

- Model for the ratio of total revenue to costs

$$\ln\left(\frac{r_{it}}{c_{it}}\right) = ln(c_{it})\beta_1 + ln(f_{it})\beta_2 + ln(m_{it})\beta_3 + \ln(p_{it})\,\beta_4 + \ln(e_{it})\,\beta_5 + \ln(w_{it})\,\beta_6 + Y20_{it}\,\beta_7 + \nu_i + \varepsilon_{it}$$

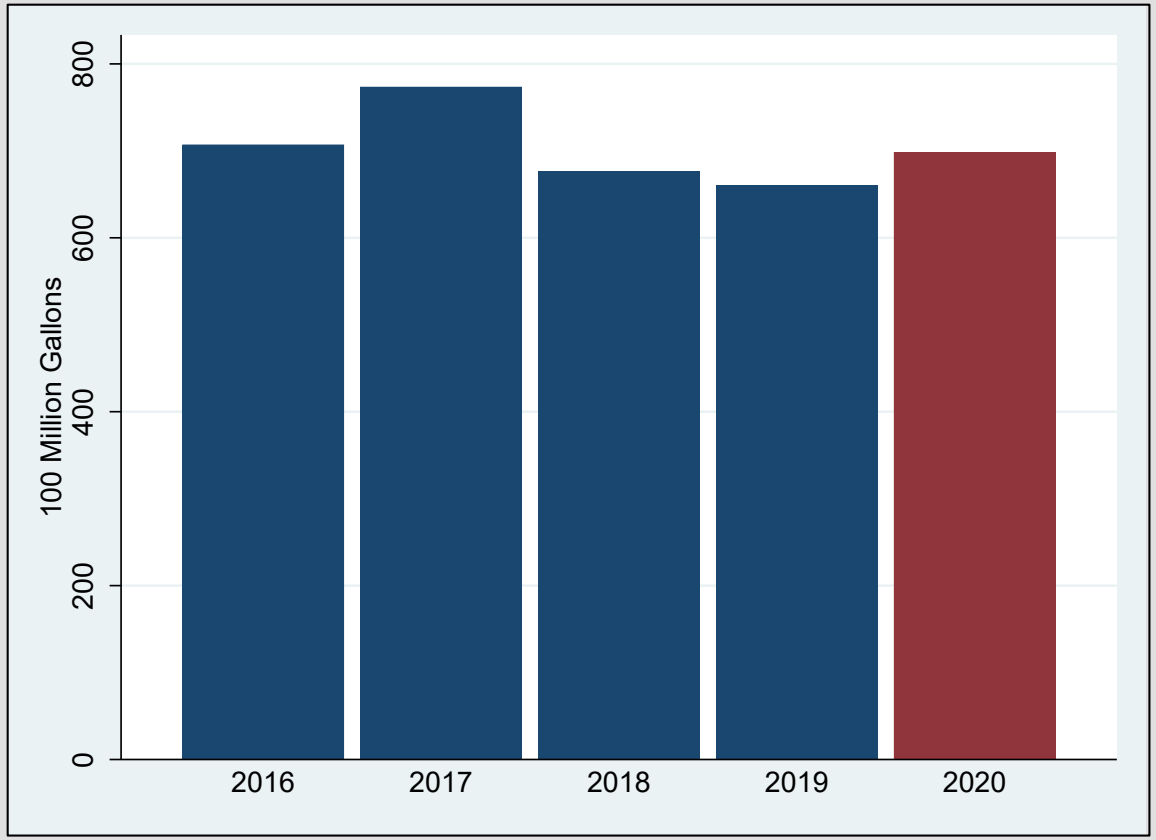
$i = water\ utility$
$t = year$
$r = revenue$
$c = costs$

$y = customers$
$f = fixed\ water\ rate$
$m = volumetric\ water\ rate$
$p = total\ precipitation$

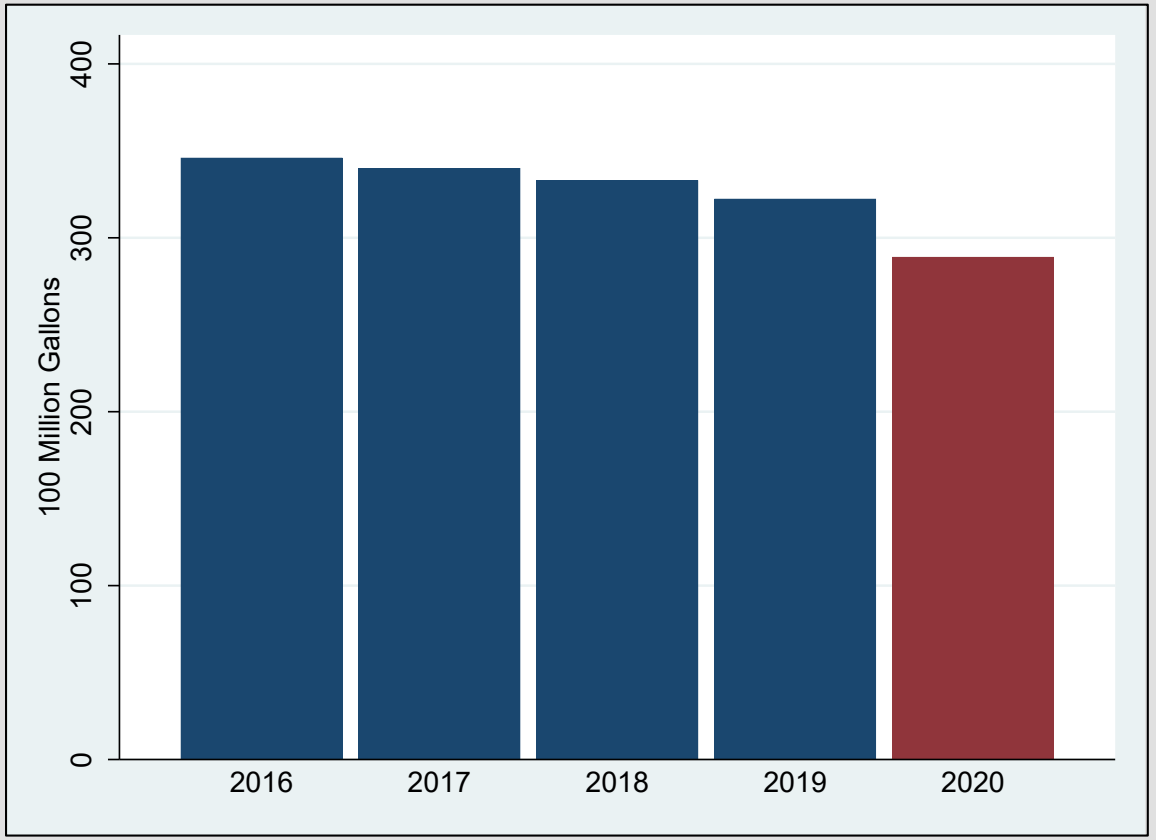
$e = price\ of\ electricity$
$w = price\ of\ labor$
$v = water\ utility\ fixed\ effects$
$\varepsilon = error$

Results: Total Water Use

Total Residential Water Use in Wisconsin by Year

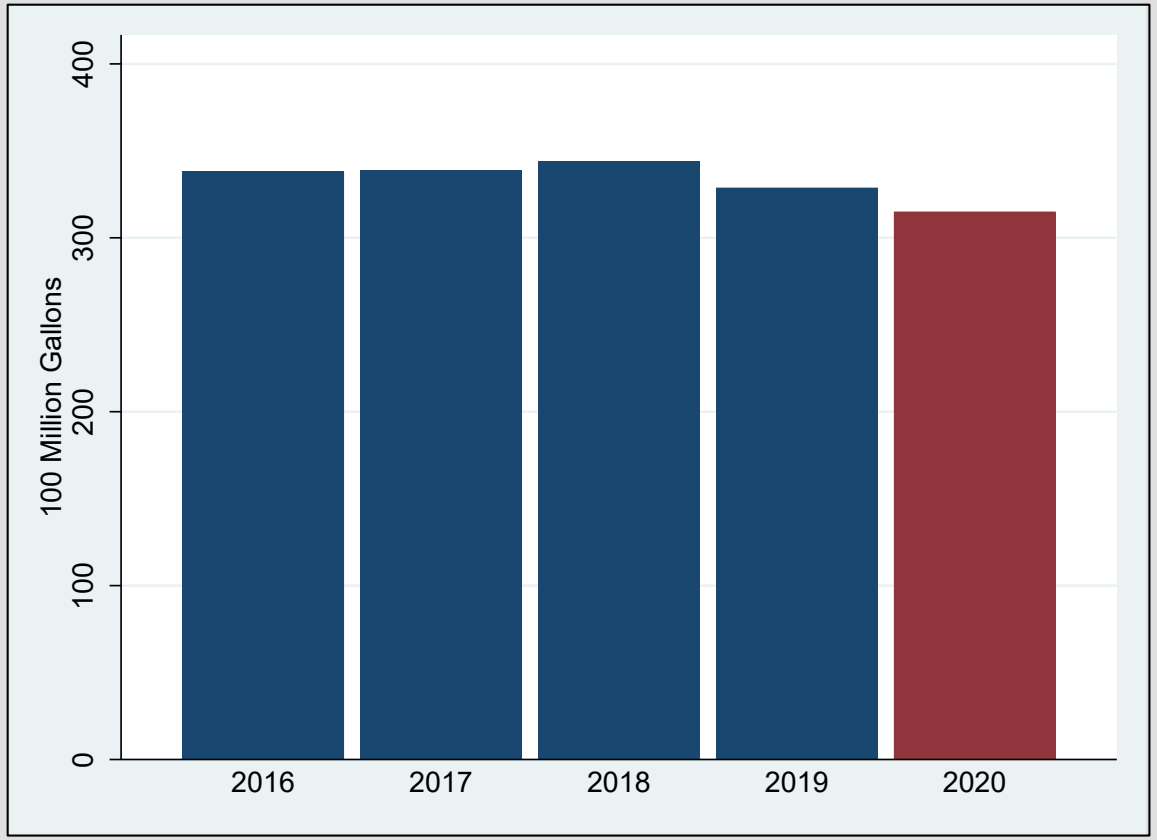


Total Commercial Water Use in Wisconsin by Year

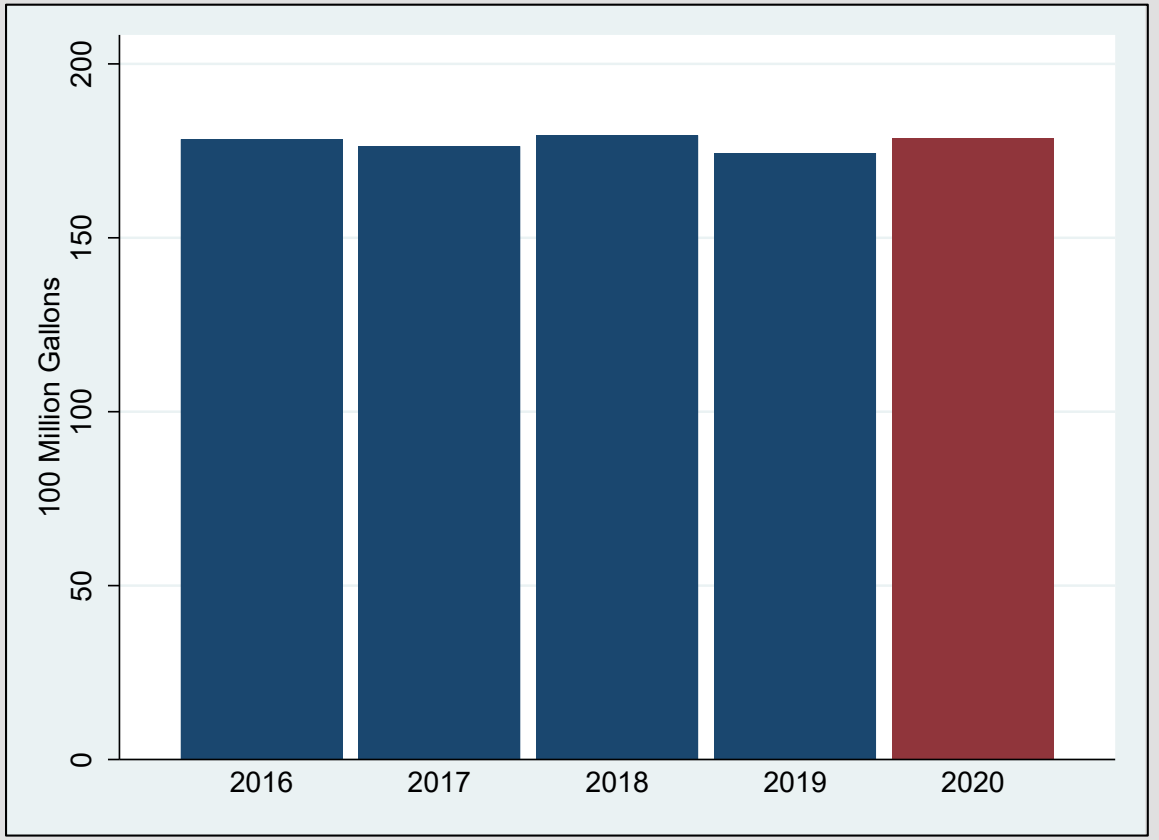


Results: Total Water Use

Total Industrial Water Use in Wisconsin by Year



Total Other Water Use in Wisconsin by Year



Results: Paired T Tests

Difference in water use between consecutive years (1000 Gallons)

	Residential	Commercial	Industrial	Other	Total
2017 - 2016	-1,650.5*	-1,275.8*	96.7	-128.5	-2,897.2*
2018 - 2017	522.0	-128.9	809.1	43.8	1,612.9
2019 - 2018	-2,600.6*	-1,439.4*	-1,811.3*	-584.3*	-6,747.1*
2020 - 2019	7,255.4*	-4,146.1*	-1,904.1*	518.1*	1,861.7

* $p < 0.05$

Results: Paired T Tests

Difference in per customer water use between consecutive years (1000 Gallons)

	Residential	Commercial	Industrial
2017 - 2016	-0.6*	-2.4*	-38.8
2018 - 2017	0.2	1.1	62.3
2019 - 2018	-1.0*	-5.3*	-154.5*
2020 - 2019	2.2*	-12.7*	-60.5

* $p < 0.05$

Results: Panel Regression

Revenue (N =1681, Sys.=337)

Variable	Coefficients
ln(c)	0.158
ln(f)	0.275*
ln(m)	0.362*
ln(p)	-0.015
Y20	0.014*

* $p < 0.05$

Revenue to cost ratio (N =1671, Sys.=335)

Variable	Coefficients
ln(c)	0.044
ln(f)	0.223
ln(m)	0.157
ln(e)	-0.009
ln(w)	-0.099*
ln(p)	-0.007
Y20	-0.013

* $p < 0.05$

Conclusions

- Behavioral and policy responses to COVID-19 led to changes in water use
  - Significant and meaningful increase in average residential water use
  - Significant and meaningful decrease in average commercial water use
  - No clear impact on industrial and other water use
  - Nonsignificant increase in average total water use

- Average revenue is significantly larger in 2020 than in 2016–2019, after controlling for key determinants

- Average revenue to cost ratio is not statistically different in 2020 than in 2016–2019
  - Implies that increased revenue is offset by increased cost
  - COVID-19 did not, on average, affect water providers' net revenues

Conclusions

- Alternative fixed-effect panel regression models (not shown) evaluate whether COVID-19 affected smaller systems and systems with a higher proportion of residential customers differently
- Relative to large water systems, small and medium systems experienced greater increases in revenue in 2020
- Water systems with a high proportion of residential customers experienced greater increases in revenue in 2020
- The revenue to cost ratio was not affected by system size or the proportion of residential customers

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Descriptive Statistics

	Description	Mean	Std. Dev.
Revenue	Total revenue ($1000)	1,014.08	1,524.84
Revenue to Cost Ratio	Ratio of total revenue to total cost	1.17	0.22
Fixed Water Rate	Service change for residential customer ($/month)	9.44	6.13
Volumetric Water Rate	Volumetric change for residential customers with average water use ($/1,000 gallons)	4.20	1.80
Price of electricity	Average price of electricity ($/kWh)	0.13	0.03
Price of labor	Average wage rate of full time employees ($/month)	3,642.32	1,616.70
Precipitation	Total annual precipitation for county where utility is located (inches)	4.92	1.03

All dollar values in 2020 USD