Winnipeg

# The Effect of Price Changes on the Demand for Parking in Winnipeg

## TECHNICAL REPORT

Economic Research · April 2020

# Executive Summary

This document summarizes the technical analysis conducted on parking data provided by the Winnipeg Parking Authority (WPA) to examine what factors affect the demand for on-street and hospital parking in zones and lots under the WPA's jurisdiction. In particular, the June 1, 2018 parking rate increase on parking demand is analyzed, along with other factors such as weather, price of gas, major downtown events, bus fares, and seasonal trends.

Using OLS regression to control for other factors, the estimated effect of the June 1, 2018 price increase of $1.50 per hour on parking demand is as follows: [1]

1. **Low Demand Zones:** the rate increase from $1.00 to $2.50 an hour (150% price increase) is estimated to have caused, on average:
    a. **37% decrease (2,740 hours)** in the total amount of hours parked by all customers on a daily basis
    b. **18% decrease (16 minutes)** in the average number of minutes parked per transaction
2. **High Demand Zones:** the rate increase from $2.00 to $3.50 an hour (75% price increase) is estimated to have caused, on average:
    a. **29% decrease (1,087 hours)** in the total amount of hours parked by all customers on a daily basis
    b. **13% decrease (9 minutes)** in the average number of minutes parked per transaction
3. **Hospital Zones:** the rate increase from $2.00 to $3.50 an hour (75% price increase) is estimated to have caused, on average:
    a. **29% decrease (545 hours)** in the total amount of hours parked by all customers on a daily basis
    b. **17% decrease (16 minutes)** in the average number of minutes parked per transaction

Overall, the data shows that the increase in hourly parking rates caused a significant and definitive decrease in the total amount of hours parked by customers across all three lot types, while simultaneously encouraging higher turnover resulting in the average customer parking for a shorter period of time.

Additional models are used to examine the impact that nearby road and sewer network construction and downtown property crime and violent crime have on total hours parked in low and high demand zones. The results **did not find any evidence** that road construction, sewer construction, property crime, and violent crime have an affect on total amount of hours parked on a monthly basis after controlling for other factors.

Further, the revenue-maximizing hourly rate for both low and high demand zones is examined. It is estimated that the current hourly rates of $2.50 for low demand and $3.50 for high demand zones are very close to the revenue-maximizing rate based on the available data.

The following sections provide more detail on factors affecting the demand for parking in WPA zones.

Please consult the appendix for more information on data sources and the results of all regression models used in this report.

[1] Total hours parked do not include paid parking hours recovered from construction activity.

# Price: Effect on Demand

## Generalized Price Effects

Table 1 below summarizes the average effects of a $1.00 increase in the hourly rate of parking on the average total amount of hours parked on a daily basis, average total amount of transactions on a daily basis, and the average minutes parked per transaction. The additive inverse of the effects below can also give an idea of what effect a $1.00 *decrease* in the hourly rate might have.

**Table 1: Average Effects of $1.00 Increase in Hourly Parking Rate**

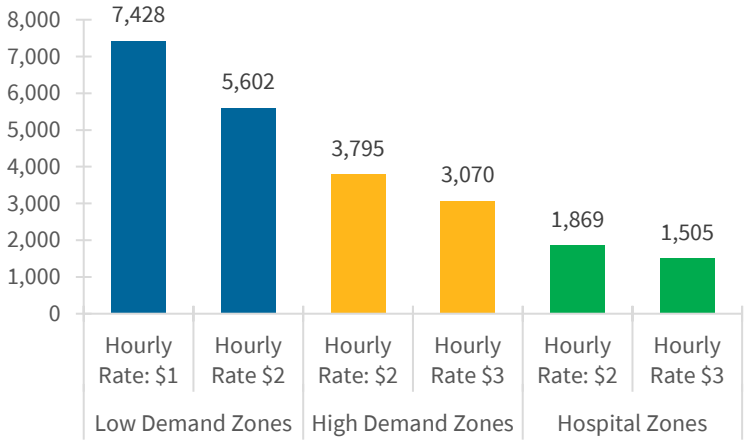
| Variable | | Low Demand Zones | High Demand Zones | Hospital Zones |
|---|---|---|---|---|
| Hours Parked | Avg. Total Daily Hours Parked [2] | 7,428 | 3,795 | 1,869 |
| | **Effect of $1.00 increase in Hourly Rate** | **-1,826** | **-725** | **-363** |
| | Effect as % of avg. | -25% | -19% | -19% |
| Transaction Counts | Avg. Total Daily Transactions [1] | 5,117 | 3,425 | 1,168 |
| | **Effect of $1.00 increase in Hourly Rate** | **-738** | **-368** | **-101** |
| | Effect as % of avg. | -14% | -11% | -9% |
| Minutes Parked per Transaction | Avg. Minutes Parked per Transaction [1] | 87 | 66 | 96 |
| | **Effect of $1.00 increase in Hourly Rate** | **-11** | **-6** | **-11** |
| | Effect as % of avg. | -12% | -9% | -11% |

These average effects suggest that for every one dollar increase in the hourly rate of parking, the total amount of hours parked on a daily basis will, on average, decrease by 1,826 hours in low demand zones, decrease by 725 hours in high demand zones, and decrease by 363 hours in hospital zones. Figure 1 below compares how the total amount of hours parked daily will change under two scenarios: the first scenario is where hourly parking rates remained the same as they were before June 1, 2018 and the second scenario is where the hourly rate is increased by one dollar.

Simultaneously, a one dollar increase in the hourly rate will, on average, cause an individual customer to park for 11 minutes less in low demand zones, 6 minutes less in high demand zones, and 11 minutes less in a hospital zone, resulting in higher turnover.

For full regression results using daily data, please see Appendix B.

**Figure 1: Average Daily Hours Parked, before and after $1 Price Increase**

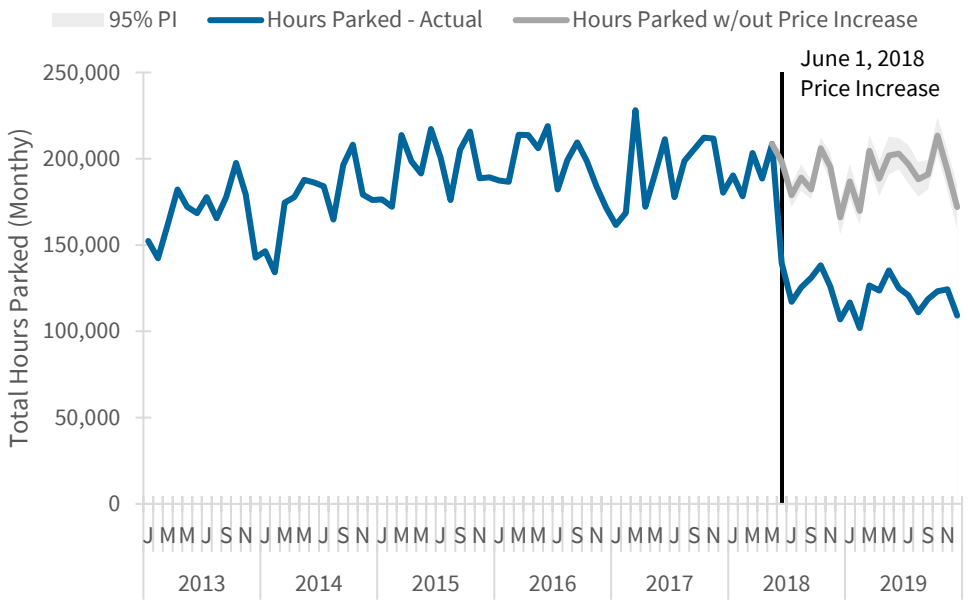



[2] Represents daily statistics prior to the June 1, 2018 price increase (i.e. for the time period of January 1, 2013 to May 31, 2018). This is presented to give readers an idea of what the parking statistics look like on a daily basis at their original rates. Does not include official holidays or Sundays when parking is free.

## Price Effects: Low Demand Zones

Figure 2 shows the total amount of hours parked by month in low-demand zones from January 2013 to December 2019. The grey line in figure 2 shows the estimated number of hours that would have been parked if the June 1, 2018 hourly rate increase would have never taken effect.

### Figure 2: Low Demand Hours Parked



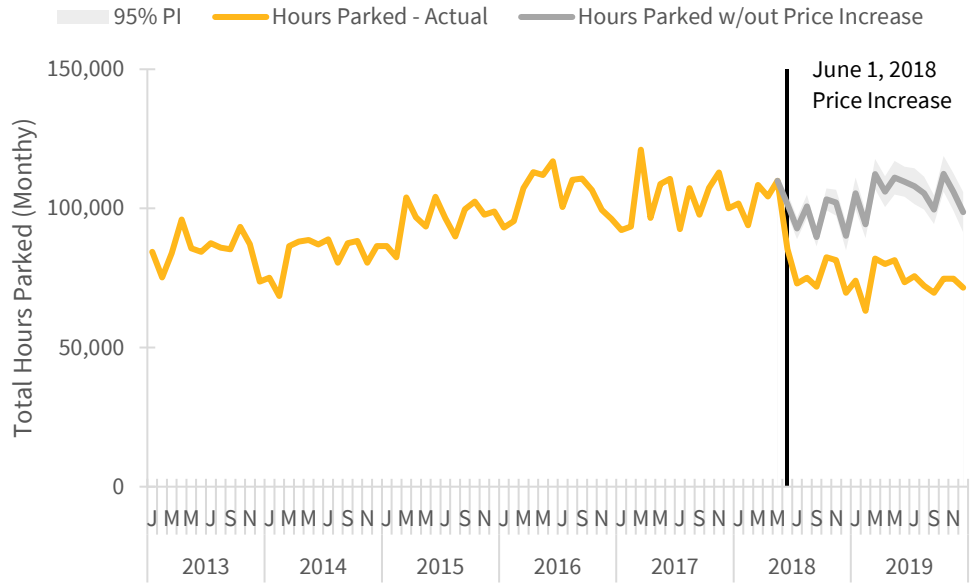

Overall, between June 1, 2018 and December 31, 2019 it is estimated that **1.3 million fewer hours** were parked due to the price increase, but an additional **$2.2 million in revenue** was generated.

## Price Effects: High Demand Zones

Figure 3 also shows the total amount of hours parked over the same timeframe, along with the estimated amount of hours parked in the absence of the hourly rate increase for high demand zones.

It is estimated that from June 1, 2018 to December 31, 2019 the hourly rate increase resulted in **517,337 fewer** hours parked and an additional **$1.1 million in revenue**.

### Figure 3: High Demand Hours Parked

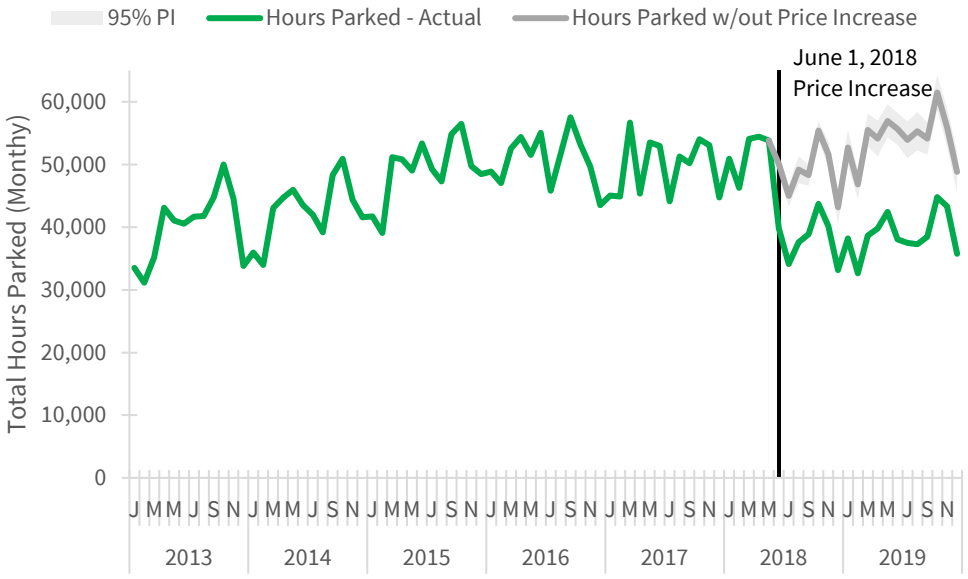


## Price Effects: Hospital Zones

The actual hours parked in hospital zones along with the estimated amount of hours parked in the absence of an hourly rate increase is shown in figure 4.

From June 1, 2018 to December 31, 2019 it is estimated that the hourly rate increase caused **259,876 fewer** hours to be parked and generated an additional **$581,502 in revenue** from hospital zones.

### Figure 4: Hospital Zones Hours Parked




## Price Effects: Overall Total

When all three lot types are combined, it is estimated that between June 1, 2018 and December 31, 2019, the June 1, 2018 hourly rate increase caused **2.08 million fewer hours** to be parked and an additional **$3.9 million in revenue** to be generated. Table 2 below contrasts the actual amount of hours parked and revenue generated to the estimated hours parked and revenue generated if the hourly rate increase would have never taken place.

### Table 2: Price Effects by Time Period [3]

| Time Period | Hours Parked (Millions) | | | | Revenue ($ Millions) | | | |
|---|---|---|---|---|---|---|---|---|
| | Actual | Estimated ( w/out Price Increase) | Diff. (actual vs. est.) | % Diff. | Actual | Estimated (w/out Price Increase) | Diff. (actual vs. est.) | % Diff. |
| One Year Prior to Price Increase (June 1, 2017 to May 31, 2018) | 4.22 | - | - | - | $6.08 | - | - | - |
| Year One after Price Increase (June 1, 2018 to May 31, 2019) | 2.87 | 4.09 | -1.22 | -30% | $8.55 | $5.90 | $2.64 | 45% |
| Year Two after Price Increase (June 1, 2019 to December 31, 2019) | 1.62 | 2.48 | -0.86 | -35% | $4.83 | $3.61 | $1.23 | 34% |
| **Total Effect or Price Increase (June 1, 2018 to December 31, 2019)** | **4.49** | **6.57** | **-2.08** | **-32%** | **$13.38** | **$9.51** | **$3.87** | **41%** |

[3] Revenue does not include paid parking hours recovered from construction activity.

# Other Factors: Effect on Demand

## Weather, Events, Gas Prices, and Bus Fares

Table 3 below provides estimates on how various factors, including price, downtown events, gas prices, bus fares, and weather influence the total demand for parking on a daily basis in Winnipeg, on average. These results utilize daily parking data in order to predict the effects various events have on daily hours parked.

Factors like Jets' home games, Moose home games, the Fringe Festival, and warmer weather all have a positive and statistically significant effect on the amount of hours parked. The Canada Summer Games, cooler weather, and precipitation tend to have a negative impact on hours parked in a day.

### Table 3: Estimates on Factors influencing Total Daily Hours Parked in Winnipeg by Zone Type (Daily Regression Model) [4]

| Avg. Total Daily Hours Parked: [5] | Low Demand Zones 7,428 | | High Demand Zones 3,795 | | Hospital zones 1,869 | |
|---|---|---|---|---|---|---|
| **Factor** | **Effect on Hours Parked** | **Effect as % of Average** | **Effect on Hours Parked** | **Effect as % of Average** | **Effect on Hours Parked** | **Effect as % of Average** |
| Hourly Rate: per $1 increase | -1,826 | -25% | -725 | -19% | -363 | -19% |
| Winnipeg Jets Home Game | 246 | 3% | 166 | 4% | Not Included in Model | |
| Winnipeg Jets White Out Party | - | - | - | - | | |
| Manitoba Moose Home Game | 216 | 3% | 198 | 5% | | |
| BellMTS Centre Major Event | - | - | - | - | | |
| Canada Summer Games | -907 | -12% | -527 | -14% | | |
| Fringe Festival | 861 | 12% | 208 | 5% | | |
| Gas Prices: per 5 cent increase | -1 | 0% | -1 | 0% | 0 | 0% |
| Bus Fare: per 5 cent increase | 52 | 1% | 70 | 2% | 47 | 3% |
| Temperature: per 5 degree C increase | 111 | 1% | 52 | 1% | 32 | 2% |
| Precipitation: per 5 mm | -131 | -2% | -68 | -2% | -37 | -2% |

[4] Seasonal factors in the model are not reported in this table. Cells that contain a dash indicate that the variable had a statistically insignificant relationship on parking demand (p >= .05). For full regression results using daily data, please see the Appendix B.

[5] Represents average total daily hours parked prior to the June 1, 2018 price increase (i.e. for the time period of January 1, 2013 to May 31, 2018). This is presented to give readers an idea of what the parking statistics look like on a daily basis at their original hourly rates. Does not include official holidays or Sundays when parking is free.

## Retail Trends

While downtown Winnipeg and the Exchange District provide a unique selection of restaurant and retail destinations, consumer demand for the goods and services provided in this area is not immune to regional and global trends occurring in retail and food services. Moreover, demand for parking in Winnipeg's downtown and Exchange District will, in part, be driven by consumer demand to engage with the businesses in these areas.

While a consumer's decision to visit a particular store or restaurant in downtown or the Exchange District may be affected by the availability and price of nearby parking, other wider trends also affect demand. Two trends in particular may affect where consumers may spend their money:

The first major trend is the shift from in-store to online purchases. Statistics Canada reports that in 2016, 2.2% ($12 billion) of all Canadian retail trade occurring in Canada was in the form of online e-commerce sales. By 2019, the share of purchases done online had risen to 3.6% ($22 billion).[6] While online sales still make up only a small fraction of total retail trade activity in Canada, it is clear that the online share is increasing every year which means brick-and-mortar stores are receiving a smaller share of Canadians' disposable income every year.

The second major trend that may affect retail specifically in downtown Winnipeg and the Exchange District is the opening of Winnipeg's first outlet mall, *Outlet Collection Winnipeg,* on May 3, 2017.[7] This greenfield development in the south-west area of Winnipeg represented an additional 570 thousand square feet of retail space added to the local market, which increased total commercial space in Winnipeg by approximately 2 per cent. While this may not seem that significant, it is estimated that the commercial space added by *Outlet Collection Winnipeg* is more than four times the total amount of commercial space within the entire Exchange District neighborhood.[8]

To summarize, the trend towards online retail taking up a greater share of total retail sales, along with the opening of a very large retail hub in south-west Winnipeg may also be influencing consumer behavior as more Winnipeggers potentially chose to spend their disposable income online or at new retail options outside downtown and the Exchange district. This shift in consumer behavior may also have an effect on the demand for on-street parking in the Exchange and downtown.

[6] Source: Statistics Canada. Table 20-10-0072-01, Retail E-commerce sales, unadjusted (x 1,000)
[7] Source: CTV Winnipeg. *New Winnipeg Outlet Mall Stores Unveiled, Grand Opening Announced,* March 8, 2017. Accessed March 23, 2020.
[8] Source: City of Winnipeg internal data, author's calculations. For the purposes of this report, commercial space is considered to be any building with a model code of *C-13 Stores, Commercials*.

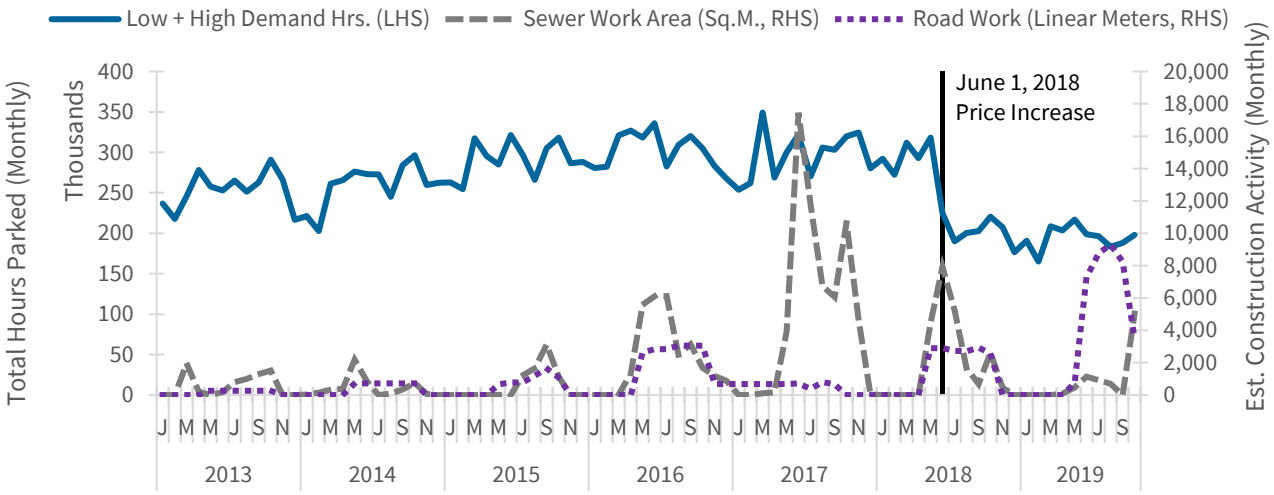
## Crime and Construction

Due to a lack of more granular data, a monthly parking demand model is used to examine if downtown monthly property crime, violent crime, road construction, and wastewater infrastructure construction in the downtown area have an impact on total monthly hours parked. The model's results suggest all these factors are statistically insignificant.

While this does not *conclusively* mean these factors do not affect the demand for parking, it means that based on the information currently available, no empirically significant relationship could be found.[9]

To display the relationship to construction activity, figure 5 shows the total amount of monthly hours parked across the low and high demand zones versus construction activity that occurred within 110 meters of pay stations. To see monthly crime statistics, please visit the Winnipeg Police Service's website for more details. For full monthly regression results, please see Appendix C.

### Figure 5: Monthly Hours Parked vs. Nearby Construction Activity




## A Note on the Impacts of Novel Coronavirus (COVID-19)

This report has been written during the outbreak of a global health pandemic caused by COVID-19. Significant efforts have been undertaken by governments across the world, including in Canada, to limit social interactions among the entire population to slow the spread of the virus. These efforts have resulted in much of the population sheltering in their homes and many non-essential businesses closing down temporarily.

While it is too early to comment specifically on the virus' effect on the demand for parking in Winnipeg, it can be assumed that significant social distancing among the population and a decline in general economic activity will likely have a negative impact on the total amount of hours parked for the duration of the pandemic.

[9] Conflating this relationship is the fact that hours parked is positively influenced by warmer weather in the spring and summer months, and construction and property crime also tend to increase in the summer months.

# Revenue Maximization Analysis

This section provides an analysis on what hourly rate would maximize daily revenue to the Winnipeg Parking Authority for low and high demand zones. As the hourly rate of parking increases, the demand decreases and eventually there will come a point where any additional increase in the hourly rate will result in lower total revenue than before. Therefore, the revenue-maximizing rate is considered the rate at which revenue is maximized, and any hourly rate increase beyond this will result in less total annual revenue to the parking authority.

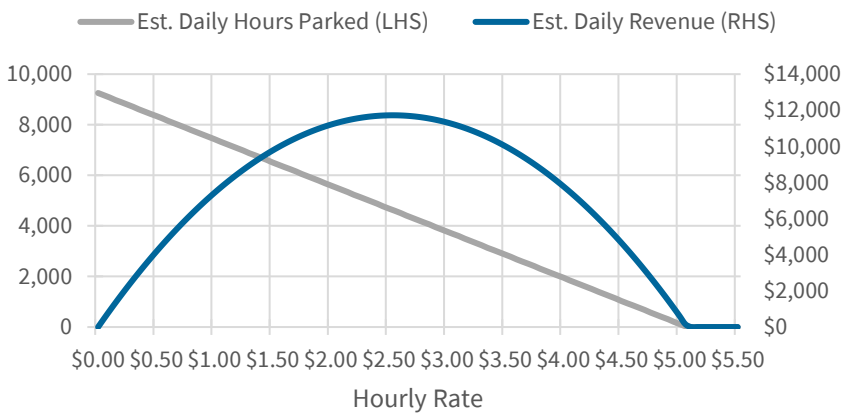
The results suggest that the current hourly rates for both low demand and high demand zones are near the revenue-maximizing rates. Any substantial increase in hourly parking rates would likely lead to revenue levels that are lower than they would have otherwise been if the rate were not increased further.

It is important to note that the City of Winnipeg does not set the price of parking in order to maximize revenue. Rather, a number of factors are considered when establishing hourly parking rates, including optimal turnover rates to ensure availability of short-term parking as well as the rates set in other comparable North American cities.

## Low Demand Zones

The results from the daily regression model presented in table 1 suggest that the revenue-maximizing hourly rate for low demand zones is estimated to be $2.55 (five cents higher than the current hourly rate). Relative to an hourly rate of $1 per hour, an hour rate of $2.55 per hour is estimated to net an additional $4,294 per day (58%) and decrease hours parked by 2,830 (-38%) per day.

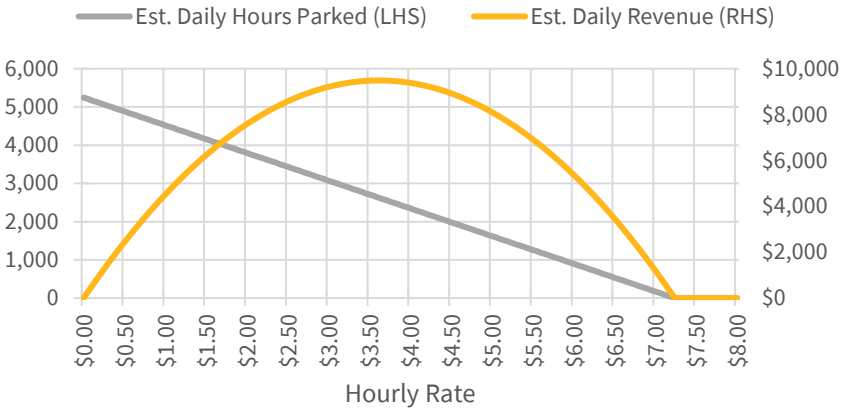
### Figure 6: Low Demand - Daily Revenue Curve




## High Demand Zones

Using the same methodology, the revenue-maximizing hourly rate for high demand zones is estimated to be $3.60 (ten cents higher than the current hourly rate). Relative to an hourly rate of $2 per hour, an hour rate of $3.60 per hour is estimated to net an additional $1,897 per day (25%) and decrease hours parked by 1,159 (-31%) per day.

### Figure 7: High Demand - Daily Revenue Curve



# Appendix A: Data Sources and Limitations

Data for this analysis along with their applicable notes are as follows:

- **Daily Parking data:** All data related to pay station and digital pay-by-phone transactions are from the Winnipeg Parking Authority (WPA). Both physical pay station and pay-by-phone transactions are combined in all analyses. Declined transactions are excluded from the analysis. All lots under the WPA's jurisdiction that are not high demand zones, low demand zones, or hospital zones are excluded from this analysis.
- **Monthly Parking data:** Daily parking data from the WPA is rolled up to the monthly level to derive monthly statistics.
- **Dates for Winnipeg Jets Games, Whiteout Parties, Moose Games, and BellMTS Centre Events:** Various sources including media outlets, Wikipedia, and BellMTS Centre's online event calendar are used to determine dates of various events.
- **Price of Gas:** data from gasbuddy.com for Winnipeg is used to determine the local average price of regular gasoline on each day.
- **Daily Temperatures and Precipitation:** Weather data is obtained from the Federal Government of Canada's Department of Environment and Natural Resources for the "Winnipeg The Forks" weather station (Climate ID 5023262).
- **Crime Data:** Crime data for the downtown Winnipeg community area is obtained from the Winnipeg Police Service.
- **Nearby Sewer Work Surface Area:** Data used to approximate the volume of sewer work within 110 meters of pay stations is obtained using geospatial data from the City of Winnipeg's geospatial warehouse. Please note that this data is extremely approximate given the rough timelines of the scheduled work available in the database. Data is measured in square meters of surface area marked for work within the mapping program.
- **Nearby Road Work Area:** Data used to approximate the volume of road work within 110 meters of pay stations is obtained using geospatial data from the City of Winnipeg's geospatial warehouse. Please note that this data is extremely approximate given the rough timelines of the scheduled work available in the database. Data is measured in linear meters of road marked for work within the mapping program.

The primary limitation of this analysis is that there is only one price change to analyze, which means it cannot be determined if an $X change in price will generally lead to the same change in hours parked for every point along the demand curve. In other words, consumers' response to a change in the hourly rate of parking may not be linear (e.g. an increase in the hourly rate from $1 to $2 may cause a different reaction in consumers than a change from $2 to $3 even though they both represent a $1 increase in the hourly rate), but we are unable to provide additional analysis since only one price change has occurred. Given this, it is important to understand that the values and figures in this report assume that consumers respond in a linear way to price changes and as such, all findings are estimates. We may observe that in the future consumers react in a way that is different from what this report estimates.

Further, another limitation is that currently it is not possible to analyze the impact of bike lane and active transportation network construction on parking demand in downtown Winnipeg or the

Exchange district because digital pay-by-phone transaction data, which makes up a significant proportion of total parking transactions, cannot be geolocated to specific parking areas. As such, it is currently not possible to understand trends in the demand for parking by specific parking locations, such as parking spots near or far away from newly implemented bike and active transportation networks. If this functionality were to be implemented in the future, then analysis could take place once sufficient data becomes available.

# Appendix B: Full Daily Regression Results

Below are the full results of the daily regression models. Newey-West Standard Errors are used to correct for potential heteroskedasticty and autocorrelation among the data. Dickey-fuller and KPSS tests are run to confirm that the dependent variable is stationary in all three models.

### Daily Regression Model Results: Low Demand Parking Zones

| Dependent Variable: Low Demand Hours Parked (Daily) | | | | |
|---|---|---|---|---|
| **Variable** | **Coefficient** | **Newey-West Std. Err.** | **t** | **pvalue** |
| Hourly Rate ($) | -1826.334*** | 94.74 | -19.28 | 0.000 |
| Jets Game (home) | 245.888*** | 65.89 | 3.73 | 0.000 |
| Jets Whiteout Party | 166.595 | 264.92 | 0.63 | 0.530 |
| Moose Game (home) | 215.606** | 100.28 | 2.15 | 0.032 |
| BellMTS Centre Event (non-hockey) | -20.111 | 75.37 | -0.27 | 0.790 |
| Canada Summer Games | -907.369** | 359.01 | -2.53 | 0.012 |
| Fringe Festival | 860.69*** | 139.38 | 6.18 | 0.000 |
| Price of Gas ($/L) | -22.928*** | 3.00 | -7.64 | 0.000 |
| Price of Regular Bus Fare | 1037.117** | 422.96 | 2.45 | 0.014 |
| Daily Temperature Average ( C ) | 22.267*** | 4.91 | 4.53 | 0.000 |
| Daily Precipitation | -26.164*** | 9.48 | -2.76 | 0.006 |
| Tuesday Indicator | 1040.994*** | 82.86 | 12.56 | 0.000 |
| Wednesday Indicator | 1166.664*** | 82.59 | 14.13 | 0.000 |
| Thursday Indicator | 1274.648*** | 81.41 | 15.66 | 0.000 |
| Friday Indicator | 914.308*** | 84.73 | 10.79 | 0.000 |
| Saturday Indicator | -4473.53*** | 98.82 | -45.27 | 0.000 |
| January Indicator | -324.143 | 206.16 | -1.57 | 0.116 |
| February Indicator | 115.706 | 206.35 | 0.56 | 0.575 |
| March Indicator | 743.322*** | 201.41 | 3.69 | 0.000 |
| April Indicator | 802.581*** | 212.32 | 3.78 | 0.000 |
| May Indicator | 471.453* | 244.91 | 1.93 | 0.054 |
| June Indicator | 730.86*** | 243.61 | 3.00 | 0.003 |
| July Indicator | -351.515 | 263.05 | -1.34 | 0.182 |
| August Indicator | -356.657 | 257.23 | -1.39 | 0.166 |
| September Indicator | 791.54*** | 222.83 | 3.55 | 0.000 |
| October Indicator | 765.986*** | 207.89 | 3.68 | 0.000 |
| November Indicator | 614.557*** | 218.46 | 2.81 | 0.005 |
| Constant | 8509.765*** | 1173.83 | 7.25 | 0.000 |
| **Observations** | | | | **2,111** |
| **Adjusted R-squared** | | | | **0.85** |

*** p<0.01, ** p<0.05, * p<0.1

## Daily Regression Model Results: High Demand Parking Zones

| Dependent Variable: High Demand Hours Parked (Daily) | | | | |
|---|---|---|---|---|
| **Variable** | **Coefficient** | **Newey-West Std. Err.** | **t** | **pvalue** |
| Hourly Rate ($) | -724.67*** | 60.48 | -11.98 | 0.00 |
| Jets Game (home) | 166.256*** | 33.86 | 4.91 | 0.000 |
| Jets Whiteout Party | 145.622 | 90.64 | 1.61 | 0.108 |
| Moose Game (home) | 197.863*** | 54.49 | 3.63 | 0.000 |
| BellMTS Centre Event (non-hockey) | -21.983 | 38.06 | -0.58 | 0.564 |
| Canada Summer Games | -526.562*** | 202.60 | -2.60 | 0.009 |
| Fringe Festival | 208.438*** | 77.11 | 2.70 | 0.007 |
| Price of Gas ($/L) | -12.476*** | 1.61 | -7.73 | 0.000 |
| Price of Regular Bus Fare | 1403.533*** | 258.47 | 5.43 | 0.000 |
| Daily Temperature Average ( C ) | 10.362*** | 2.67 | 3.88 | 0.000 |
| Daily Precipitation | -13.586*** | 4.79 | -2.83 | 0.005 |
| Tuesday Indicator | 392.08*** | 46.61 | 8.41 | 0.000 |
| Wednesday Indicator | 399.856*** | 45.22 | 8.84 | 0.000 |
| Thursday Indicator | 439.505*** | 45.16 | 9.73 | 0.000 |
| Friday Indicator | 292.035*** | 45.58 | 6.41 | 0.000 |
| Saturday Indicator | -2711.289*** | 49.90 | -54.34 | 0.000 |
| January Indicator | -231.391** | 108.32 | -2.14 | 0.033 |
| February Indicator | -50.416 | 108.41 | -0.47 | 0.642 |
| March Indicator | 261.966** | 104.27 | 2.51 | 0.012 |
| April Indicator | 411.954*** | 114.09 | 3.61 | 0.000 |
| May Indicator | 182.296 | 128.92 | 1.41 | 0.158 |
| June Indicator | 248.128* | 132.86 | 1.87 | 0.062 |
| July Indicator | -173.373 | 143.19 | -1.21 | 0.226 |
| August Indicator | -179.77 | 136.41 | -1.32 | 0.188 |
| September Indicator | 120.152 | 120.95 | 0.99 | 0.321 |
| October Indicator | 119.924 | 115.33 | 1.04 | 0.299 |
| November Indicator | 197.834* | 115.82 | 1.71 | 0.088 |
| Constant | 2955.72*** | 656.94 | 4.50 | 0.000 |
| **Observations** | | | | **2,111** |
| **Adjusted R-squared** | | | | **0.85** |

*** p<0.01, ** p<0.05, * p<0.1

## Daily Regression Model Results: Hospital Zones

| Dependent Variable: Hospital Zones Hours Parked (Daily) | | | | |
|---|---|---|---|---|
| **Variable** | **Coefficient** | **Newey-West Std. Err.** | **t** | **pvalue** |
| Hourly Rate ($) | -363.225*** | 27.65 | -13.14 | 0.00 |
| Price of Gas ($/L) | -5.492*** | 0.81 | -6.81 | 0.000 |
| Price of Regular Bus Fare | 936.247*** | 123.69 | 7.57 | 0.000 |
| Daily Temperature Average ( C ) | 6.429*** | 1.38 | 4.67 | 0.000 |
| Daily Precipitation | -7.498*** | 2.25 | -3.34 | 0.001 |
| Tuesday Indicator | 239.942*** | 22.29 | 10.77 | 0.000 |
| Wednesday Indicator | 212.503*** | 22.81 | 9.32 | 0.000 |
| Thursday Indicator | 184.496*** | 23.26 | 7.93 | 0.000 |
| Friday Indicator | -108.916*** | 22.78 | -4.78 | 0.000 |
| Saturday Indicator | -1120.214*** | 24.38 | -45.94 | 0.000 |
| January Indicator | -80.874 | 61.14 | -1.32 | 0.186 |
| February Indicator | -5.071 | 58.90 | -0.09 | 0.931 |
| March Indicator | 120.543** | 58.35 | 2.07 | 0.039 |
| April Indicator | 217.856*** | 63.17 | 3.45 | 0.001 |
| May Indicator | 99.331 | 68.32 | 1.45 | 0.146 |
| June Indicator | 88.103 | 72.24 | 1.22 | 0.223 |
| July Indicator | -114.215 | 74.28 | -1.54 | 0.124 |
| August Indicator | -129.141* | 76.70 | -1.68 | 0.092 |
| September Indicator | 211.54*** | 69.51 | 3.04 | 0.002 |
| October Indicator | 254.115*** | 62.13 | 4.09 | 0.000 |
| November Indicator | 216.587*** | 63.32 | 3.42 | 0.001 |
| Constant | 739.372** | 326.55 | 2.26 | 0.024 |
| **Observations** | | | | **2,111** |
| **Adjusted R-squared** | | | | **0.81** |

**** p<0.01, ** p<0.05, * p<0.1*

# Appendix C: Full Monthly Regression Results

Below are the full results of the monthly regression models. As property crimes have been trending up significantly over the observed time period, the first difference is used in the analysis to ensure stationarity.

### Monthly Regression Results: Low Demand Zones

| Dependent Variable: Low Demand Hours Parked (Monthly) | | | | |
|---|---|---|---|---|
| **Variable** | **Coefficient** | **Standard Error** | **t** | **pvalue** |
| Hourly Rate ($) | -43786.165*** | 4335.61 | -10.10 | 0.00 |
| Jets Games (home, monthly total) | 778.738 | 1106.48 | 0.70 | 0.484 |
| Jets Whiteout Parties (home, monthly total) | 2195.483 | 1336.56 | 1.64 | 0.106 |
| Moose Games (home, monthly total) | 2031.74* | 1172.80 | 1.73 | 0.089 |
| BellMTS Centre Events (non-hockey) | 297.842 | 903.75 | 0.33 | 0.743 |
| Price of Gas ($/L, monthly avg.) | -651.019*** | 157.44 | -4.14 | 0.000 |
| Price of Regular Bus Fare | 6263.957 | 24089.66 | 0.26 | 0.796 |
| Monthly Temperature Average ( C ) | 325.689 | 676.12 | 0.48 | 0.632 |
| Monthly Total Precipitation | -52.574 | 68.55 | -0.77 | 0.446 |
| January Indicator | 3006.037 | 7738.19 | 0.39 | 0.699 |
| February Indicator | -3555.01 | 7474.76 | -0.48 | 0.636 |
| March Indicator | 29881.975*** | 8978.29 | 3.33 | 0.002 |
| April Indicator | 25716.914* | 13385.89 | 1.92 | 0.060 |
| May Indicator | 36102.684* | 20194.94 | 1.79 | 0.079 |
| June Indicator | 47748.641* | 24458.70 | 1.95 | 0.056 |
| July Indicator | 29310.403 | 25431.80 | 1.15 | 0.254 |
| August Indicator | 23769.368 | 24293.72 | 0.98 | 0.332 |
| September Indicator | 38908.669* | 20760.62 | 1.87 | 0.066 |
| October Indicator | 38371.537** | 14709.54 | 2.61 | 0.012 |
| November Indicator | 19395.572** | 9064.91 | 2.14 | 0.037 |
| Downtown Property Crime, first difference (monthly total) | -5.556 | 16.15 | -0.34 | 0.732 |
| Downtown Violent Crime (monthly total) | 17.301 | 55.81 | 0.31 | 0.758 |
| Nearby Sewer Work Surface Area (Square Meters) | -0.381 | 0.67 | -0.57 | 0.569 |
| Nearby Road Work Area (Linear Meters) | -1.033 | 1.15 | -0.90 | 0.371 |
| Constant | 249373.58*** | 67109.21 | 3.72 | 0.000 |
| **Observations** | | | | **81** |
| **Adjusted R-squared** | | | | **0.87** |

## Monthly Regression Results: High Demand Zones

| Dependent Variable: High Demand Hours Parked (Monthly) | | | | |
|---|---|---|---|---|
| **Variable** | **Coefficient** | **Standard Error** | **t** | **pvalue** |
| Hourly Rate ($) | -17212.811*** | 2234.93 | -7.70 | 0.00 |
| Jets Games (home, monthly total) | 619.342 | 570.37 | 1.09 | 0.282 |
| Jets Whiteout Parties (home, monthly total) | 788.392 | 688.97 | 1.14 | 0.257 |
| Moose Games (home, monthly total) | 2186.356*** | 604.55 | 3.62 | 0.001 |
| BellMTS Centre Events (non-hockey) | 34.734 | 465.86 | 0.07 | 0.941 |
| Price of Gas ($/L, monthly avg.) | -257.202*** | 81.16 | -3.17 | 0.002 |
| Price of Regular Bus Fare | 9888.228 | 12417.76 | 0.80 | 0.429 |
| Monthly Temperature Average ( C ) | -25.136 | 348.53 | -0.07 | 0.943 |
| Monthly Total Precipitation | -45.594 | 35.34 | -1.29 | 0.202 |
| January Indicator | -486.693 | 3988.89 | -0.12 | 0.903 |
| February Indicator | -3321.458 | 3853.09 | -0.86 | 0.392 |
| March Indicator | 11721.216** | 4628.14 | 2.53 | 0.014 |
| April Indicator | 16434.06** | 6900.17 | 2.38 | 0.021 |
| May Indicator | 20508.183* | 10410.10 | 1.97 | 0.054 |
| June Indicator | 23081.278* | 12607.99 | 1.83 | 0.072 |
| July Indicator | 15228.71 | 13109.61 | 1.16 | 0.250 |
| August Indicator | 15736.994 | 12522.95 | 1.26 | 0.214 |
| September Indicator | 14947.248 | 10701.70 | 1.40 | 0.168 |
| October Indicator | 10790.08 | 7582.49 | 1.42 | 0.160 |
| November Indicator | 7634.242 | 4672.79 | 1.63 | 0.108 |
| Downtown Property Crime, first difference (monthly total) | 0.949 | 8.33 | 0.11 | 0.910 |
| Downtown Violent Crime (monthly total) | 47.564 | 28.77 | 1.65 | 0.104 |
| Nearby Sewer Work Surface Area (Square Meters) | 0.447 | 0.34 | 1.30 | 0.198 |
| Nearby Road Work Area (Linear Meters) | 0.526 | 0.59 | 0.89 | 0.377 |
| Constant | 103013.289*** | 32962.22 | 3.13 | 0.003 |
| **Observations** | | | | **81** |
| **Adjusted R-squared** | | | | **0.79** |

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