Briefing Note
November 2010

Parking Demand Elasticity in the CBD: An Analysis Comparing Calgary with 43 International Cities

Executive Summary

Introduction

This report estimates the price effects of a change in the number of parking stalls in downtown Calgary. Consequently, the report estimates the responsiveness of price changes to the change in the supply of parking stalls in downtown.

Since time series data was only available from 2006 to 2009 for Calgary, it is not enough to provide sound analysis from the perspective of applied economics. In this report, we use cross-sectional dataset of 44 international cities to study how the price of parking reacts to the changes in parking stall numbers, by controlling the differences across cities in all the other aspects which could affect the price of parking.

Research Methodology

The market for parking was investigated from the demand and supply sides to find out the potential factors which could affect the price of parking. The demand for parking is affected by the availability and costs of public transit, the costs of driving such as the gasoline prices, the density in downtown, the personal income level of employees working in downtown area, as well as the geographic distribution of the city's population among various city centers and the local weather conditions. The supply of parking is determined by the price of land, labour, materials and capital besides the price of parking.

By combining all the factors related with parking market, an equation system was derived that describes the demand and supply of parking. This equation system leads to a reduced form which is used as the key specification function for the empirical analysis.

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Research Results

The empirical analysis was based on the observations from 44 international cities including Calgary. Econometric analysis was used to estimate the percentage change in parking rates that would be caused by a certain percentage change in parking stalls and other variables.

The elasticity of price of parking to the supply of parking stalls in downtown was estimated by controlling for the impact of other factors, by comparing Calgary with international cities. The results show that increasing parking stalls only has a negative effect on the price of parking when a city is uni-centered, otherwise an increase in the supply does not have a statistically significant effect on price. Instead, GDP per capita and the capacity of public transit in a city impact parking significantly. Cities with higher income levels tend to be less responsive to price increases, and cities have higher public transit use rate if the parking costs are more expensive.

Conclusions

The study finds that higher transit use is associated with higher parking rates, and higher GDP per capita associates with higher income level which consequently drives up the demand for automobile travel and parking. When the structure of the city is accounted for, the increase in the supply of parking spaces by 1 per cent should cause the price of parking to decrease by 0.44 per cent for uni-centered cities. Combining this parking demand elasticity with the estimation that downtown parking supply will increase by 15 per cent by 2014, we expect the price of parking is going to reduce by 7 per cent in the next five years. If GDP per capita in Calgary grows at a higher rate in the next five years, it is possible that the price reduction would be lower. If Calgary tends to grow into a multi-centered city where business offices and employment are also allocated in suburban areas besides downtown, then the price drop would even be more than expectation.

1. Introduction

This study estimates the parking demand elasticity in the Calgary's downtown core. The results show that while there is a negative relationship between the number of parking spaces [1] and price, the results are not statistically significant. The study also found that public transit use rate is positively correlated with parking rates and this is statistically significant at a 5 per cent level. This indicates that higher transit use is associated with higher parking rates. In other words, an increase in parking rates would cause individuals to seek transportation alternatives to the automobile. Gross domestic product (GDP) per capita also has a positive effect on the monthly parking rate, which is significant at a 5 per cent level. The higher GDP per capita the higher would be the income levels in the community and consequently that would drive the demand for automobile travel.

When the structure of the city is accounted for, the correlation between the number of parking spaces and parking rates becomes significant. That is to say, for uni-centered cities, when other conditions are fixed, an increase in the supply of parking spaces by 1 per cent should cause the price of parking to decrease by 0.44 per cent. It is estimated that the supply of parking stalls in downtown Calgary should increase by 15 per cent in the next five years [2]. Assuming other factors remain constant, this increase should cause the price of parking in the downtown to drop by 7 per cent. This price reduction should be lower if Calgary's GDP per capita grows at a higher rate. If Calgary trends towards a multi-centered city where business offices and employment are locating in suburban areas besides downtown, then the price drop would even be more than estimated.

This report estimates the price effects of a change in the number of parking stalls in downtown Calgary. Consequently, the report estimates the responsiveness of price changes to the change in the supply of parking stalls in downtown. This is done by developing an economic model of downtown parking. The price of parking is determined by the demand and supply for parking; in other words the market for parking. The next section of the report references past studies on parking elasticity done within and outside of The City of Calgary. Section 3 sets up the structure of the model and derives the specification function for the empirical tests. The data sample and sources are listed in section 4. Section 5 presents the empirical results, and section 6 estimates the impact of Calgary's parking supply changes on parking rates in the next five years. In the final section, the conclusions are drawn.

[1] The assumption is made that Calgary is a uni-centred city. In multi centred cities increase in the supply does not have a statistically significant effect on price. Instead, GDP per capita and the capacity of public transit in a city impact parking significantly. Cities with higher income level tend to be less elastic of price increases, and cities have higher public transit use rate if the parking costs are more expensive.

[2] The City of Calgary, Transportation.

2. Literature Review

The preferred method for measuring the responsiveness of parking rate changes to a change in the supply of parking [3] in downtown of Calgary is to obtain the time series data on parking fees and the supply of parking stalls in downtown, and do the empirical analysis data. Attempts were made to obtain data from the Calgary Parking Authority and The City of Calgary, Transportation. Time series data was only available from 2006 to 2009. From the perspective of applied economics, the information was not enough to conduct a sound analysis.

In researching this project all readily available reports on downtown parking in Calgary were referenced. These studies included the following:

> A study on price effects of demand and supply changes (WPS-No. 24.03.95) by Corporate Economics in 1995 [4], the estimation of the price effects of parking demand by Corporate Economics in 2000 [5], the review of market based parking policy by Corporate Economics in 2005 [6], and Mobility Monitor issue on Parking in the downtown Calgary by Transportation Data in 2010 [7]. In these reports, the problem of data availability was also mentioned.

The above reports used alternative methods to overcome the lack of Calgary specific data by drawing inferences from other cities and applying those conclusions to Calgary [8]. The studies assumed that Calgary has a comparable parking elasticity with other cities with similar conditions. For example, WPS-No 24.03.95 assumes that Calgary downtown has the same range of price elasticity as Vancouver and Toronto. In the Mobility Monitor by Transportation Data, the empirical relationship between downtown parking supply and transit use was adopted from Morrall and Bolger (1996), which also uses data from Calgary and 7 other Canadian cities.

In addition to the internal reports specific to Calgary, a review was made of studies on price elasticity for parking in other cities. As time series data was not available, cross-sectional analysis provided an alternative channel to check on how the price of parking reacts to the changes in the number of parking stalls after controlling for the differences across cities in employee income, downtown size, urban density in the CBD and the city, capacity of public transit, weather conditions etc.

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[3] Price elasticity of demand (PED or Ed) is a measure used in economics to show the responsiveness, or elasticity, of the quantity demanded of a good or service to a change in its price. More precisely, it gives the percentage change in quantity demanded in response to a one percent change in price (holding constant all the other determinants of demand, such as income).

[4] "Price Effects of Demand and Supply Changes for Downtown Parking", *Go-Plan Downtown Elasticity Report* (1995), WPS-No. 24.03.95.

[5] "Estimating the Price Effects of Parting Demand", *Reports for the Calgary Parking Authority* (2000)

[6] "Review of Market based Parking Policy", *Planning Development &Assessment Department Report to the SPC on Land Use, Planning and Transportation* (2005)

[7] Mobility monitor issue on Parking in downtown Calgary by Transportation Data (2010), *issue #36*

[8] The data sample used in this research included 44 cities from around the world.

3. Parking Model Specification

3.1 Chart Analysis

The first two charts show the relationship between daily and monthly parking rates and public transit; the upward slope of the line in the chart indicates that an increase in public transit use is generally associated with an increase in the daily parking rates. In Figure 1, we can see that Calgary is below the average trend. Given the public transit use rate in Calgary, the daily parking rate is less than the international average. Figure 2 shows a similar relationship of public transit and monthly parking rates. The monthly parking fee in Calgary is again below the international average level given the public transit use rate. Compared to daily parking rate, the monthly rate is closer to the international average trend.

Figure 1: Daily Parking Rate and Public Transit Use

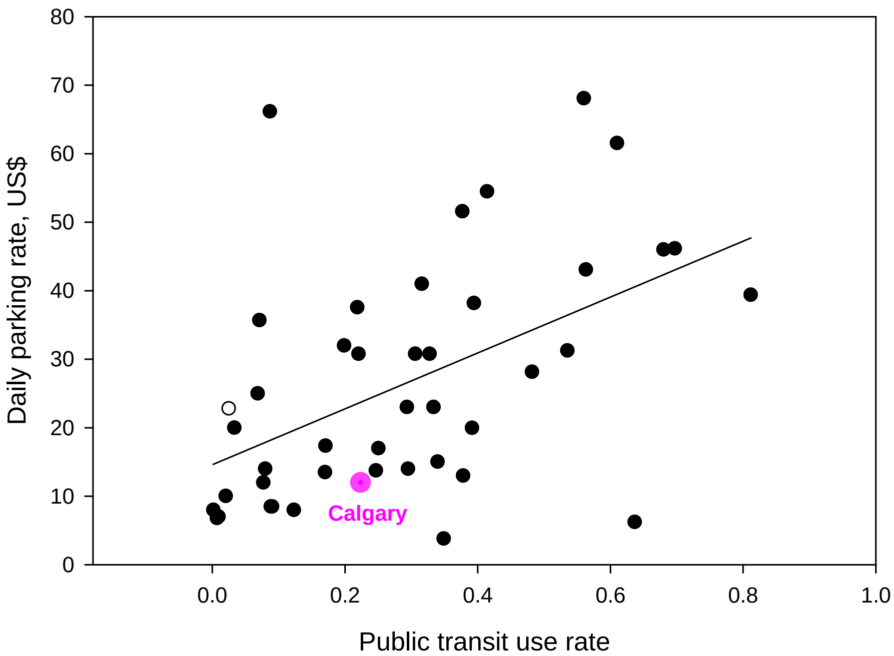
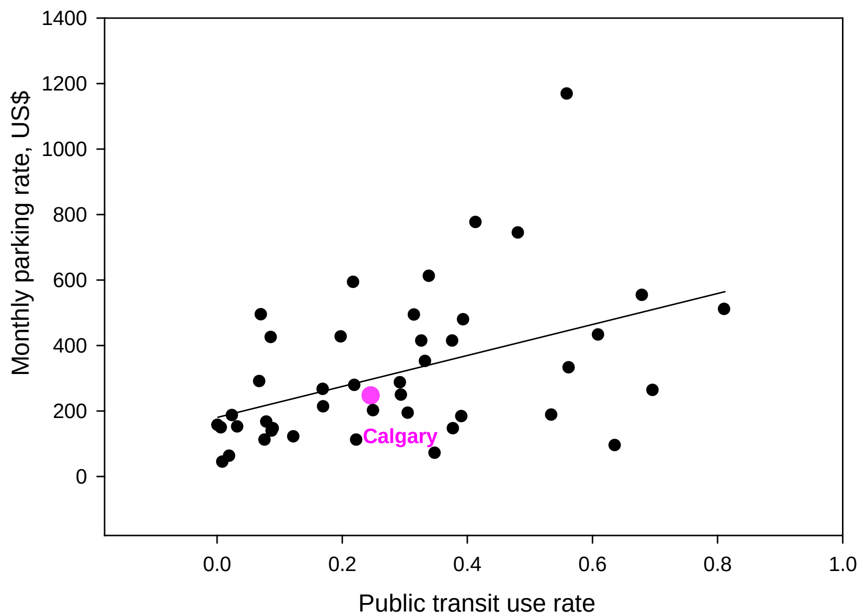


Figure 2: Monthly Parking Rate and Public Transit Use



Another variable which has a significantly positive effect is GDP per capita in each city. In the next two charts, the relationship between parking fees and GDP per capita is shown. Again, for the given level of GDP per capita, both the daily and monthly parking rates in Calgary are lower than the international average. In other cities, which have a similar level of GDP per capita with Calgary, usually the parking rates are higher. This disparity is higher for the daily parking rate.

Figure 3: Daily Parking Rate and GDP per capita

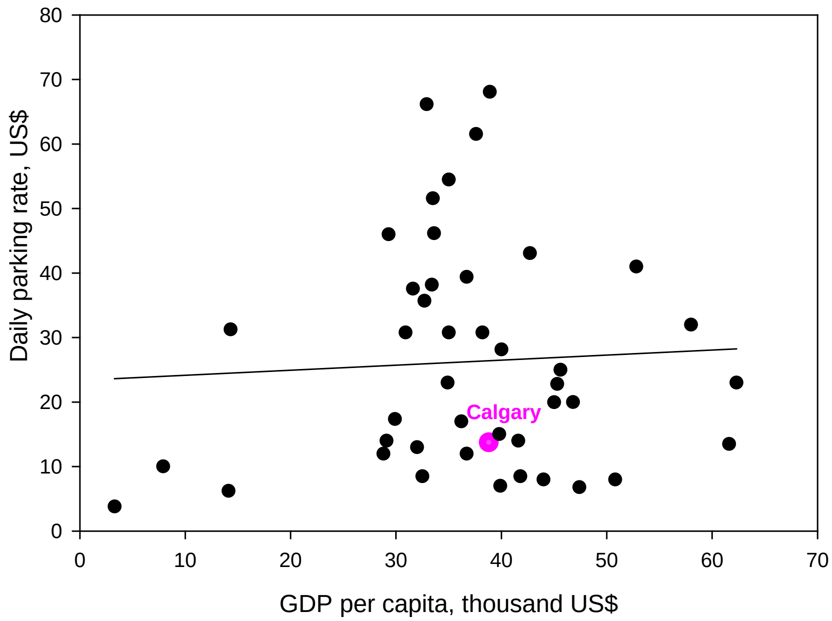
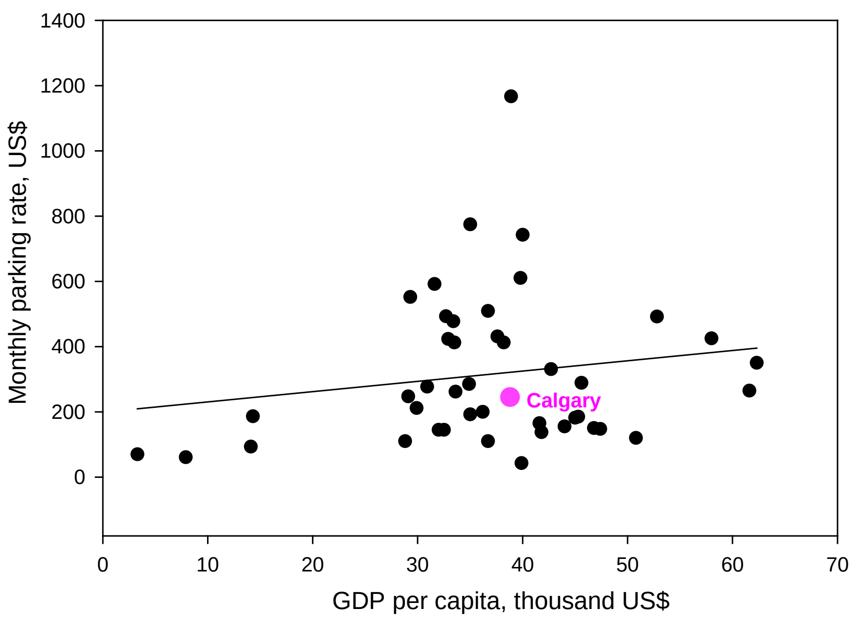


Figure 4: Monthly Parking Rate and GDP per capita



3.2 Parking Market Potential Factors

The equations, that follow, were specified to show the factors that influence the demand and supply for parking in downtown Calgary.

Demand

The demand for parking is affected by the availability and costs of public transit, the costs of driving such as gasoline prices, the density in downtown, the personal income level of employees working in downtown area, as well as the geographic distribution of the city's population among various city centers and the local weather conditions.

(1) $Demand\ for\ parking =$
$\beta_{D1} * Parking\ rate\ in\ CBD + \beta_{D2} * Public\ transit\ capacity + \beta_{D3} *$
$Costs\ of\ gasoline + \beta_{D4} * CBD\ density + \beta_{D5} * Employment\ Income + \beta_{D6} *$
$Urban\ density + \beta_{D7} * Weather\ conditions + \epsilon_D$

Supply

The supply of parking is influenced by the price of land, labour, material and capital and the price of parking.

(2) $Supply\ of\ parking = \beta_{S1} * Parking\ rate\ in\ CBD + \beta_{S2} * Construction\ wage\ costs +$
$\beta_{S3} * Construction\ land\ costs + \beta_{S4} * Construction\ material\ costs + \beta_{S5} *$
$Construction\ capital\ costs + \epsilon_S$

Solving the equation system (1) and (2) for parking rate produces the reduced form of the specification equation:

(3) $Parking\ rate\ in\ CBD = \beta_1 * Parking\ stalls\ at\ CBD + \beta_2 * Public\ transit\ capacity +$
$\beta_3 * Costs\ of\ gasoline + \beta_4 * CBD\ density + \beta_5 * Employment\ Income + \beta_6 *$
$Urban\ density + \beta_7 * Weather\ conditions + \beta_8 * Construction\ wage\ costs + \beta_9 *$
$Construction\ land\ costs + \beta_{10} * Construction\ material\ costs + \beta_{11} *$

In equation (3), the coefficient of each right hand side variable shows how a unit change in that variable would affect the parking rate. For example, the coefficient of parking stalls measures how an increase in the quantity of stalls would affect the parking rate, given that other variables are held constant.

Equation (4) re-states equation (3) in log linear form[9]. The coefficients of equation (4) reflect the elasticity[10] of the variables. For example, the coefficient of parking stalls, $\boldsymbol{\gamma_1}$,measures the responsiveness of the parking rate to a change in the quantity of parking stalls.

$$\begin{aligned}(\mathbf{4})\ \ &\mathbf{log}(\boldsymbol{Parking\ rate\ in\ CBD})\\ &= \boldsymbol{\gamma_1} * \mathbf{log}(\boldsymbol{Parking\ stalls}) + \boldsymbol{\gamma_2} * \mathbf{log}(\boldsymbol{CDB\ employment}) + \boldsymbol{\gamma_3}\\ &* \mathbf{log}(\boldsymbol{CBD\ land\ size}) + \boldsymbol{\gamma_4} * \mathbf{log}(\boldsymbol{public\ transit\ use\ rate}) + \boldsymbol{\gamma_5}\\ &* \mathbf{log}(\boldsymbol{metropolitan\ population}) + \boldsymbol{\gamma_6} * \mathbf{log}(\boldsymbol{GDP\ per\ capita}) + \boldsymbol{\gamma_7}\\ &* \mathbf{log}(\boldsymbol{urban\ size}) + \boldsymbol{\gamma_8} * \mathbf{log}(\boldsymbol{weather\ conditions}) + \boldsymbol{\varepsilon_l}\end{aligned}$$

In equation (4), the dependent variable is the average daily or monthly parking rate in the CBD area across cities. The independent variables are as follows:

Parking stalls: the total available parking stalls in the CBD area.

CBD employment: the number of employees in the CBD area reflects the demand for parking.

CBD land size: this variable measures the land size of the core area of downtown.

Public transit use rate: the ridership per capita everyday of the public transit.

Metropolitan population: the total population in the metropolitan represents the size of the economy in the city and surrounded area.

GDP per capita: the income effect of parking is reflected by GDP per capita in the area.

Urban size: the size of the urban area of the city measures the cost of travelling and the density of the city.

Weather conditions: the average annual temperature as a proxy for weather conditions.

This equation or a variant would be estimated by regression analysis. The estimated equations from the statistical analysis should have the following signs on the parameters:

- Parking stalls is expected to be negatively correlated with parking rates: the higher the quantity of parking the lower should be the parking rate. In other words an increase in the supply of parking spaces should reduce the costs of parking.
- The expected sign of CBD employment should be positive, given other variables fixed. The more employees work in the CBD, the more demand for parking spaces, and the demand tends to push up the market rate for parking.

[9] Log linear analysis is an extension of the linear regression model where the conditional relationship between two or more variables is analyzed by taking the natural logarithm of both the dependent variable and the explanatory variables.

[10] In economics, elasticity is the ratio of the percent change in one variable to the percent change in another variable. It is a tool for measuring the responsiveness of a function to changes in parameters in a relative way.

- The urban size variable is used to reflect the congestion and compactness of the CBD. For example, the CBDs of Los Angeles and Hong Kong have similar amount of employment, of around 200,000 people. However, the CBD land size is 408 hectares in Los Angeles, and only 113 hectares in Hong Kong. It means that it is almost 4 times more congested in Hong Kong, and thus it is expected that the parking rate in Hong Kong would be higher than that in Los Angeles given other conditions are held constant.
- Driving and public transit are alternative transportation modes. Higher parking rates add to the cost of driving and this should cause more people to take the public transit as alternative way of travelling. The estimated correlation between parking rates and transit use should be positive.
- The more people living in the metropolitan, the higher number of them are likely to work in the CBD area, and thus the higher demand for parking spaces. The estimated correlation between population size and parking rates should be positive
- Employees with higher income levels tend to be affected less by parking rate increases and are therefore willing to pay more for parking[11]. The estimated sign on the GDP per capita parameter is expected to be positive.
- Usually, US cities tend to be much bigger in terms of geographic area than other cities in the world. More people tend to live in the periphery than in the city core. It is more costly to provide and maintain public transit systems for cities with low population densities. Thus driving is more popular in these kinds of cities. And demand for parking is strong for lack of other travelling options. The estimated correlation between urban size and transit rate is expected to be negative.
- In cities with warmer weather, people have more options to walk or bike to work instead of driving. Thus the expected sign on the weather variable is expected to be negative.

In equation (3), some variables are highly correlated, such as construction land costs and CBD density, and construction wage costs and employment income; and consequently any estimated relationship would provide unreliable statistical estimates. Consequently, alternative specifications were used to adjust for the correlation among explanatory variables. Therefore the reduced form (equation 4) was re-written as:

$$(5)\ Parking\ rate\ in\ CBD\ =\ \alpha_1 * Parking\ stalls +\ \alpha_2 * CDB\ employment + \alpha_3 * CBD\ land\ size + \alpha_4 *\ public\ transit\ use\ rate + \alpha_5 * metropolitan\ population + \alpha_6 * GDP\ per\ capita + \alpha_7 * urban\ size + \alpha_8 * weather\ conditions + \varepsilon$$

[11] But at the same time, GDP per capita is also a proxy for the construction costs in the local area, since higher GDP per capita always indicates higher labor costs and material costs for construction of parking.

4. Data Sample and Sources

4.1 Data Sample

The data sample used in this research included 44 cities from around the world. The following is a list of the cities:

US: Los Angeles, Houston, Detroit, Washington DC, Portland, Chicago, Denver, San Francisco, San Diego, Boston, Phoenix, Sacramento, and New York;

Canada: Calgary, Vancouver, Edmonton, Toronto, Winnipeg, Ottawa, and Montreal;

Europe: Brussels, Frankfurt, Paris, Munich, Vienna, Copenhagen, Hamburg, Zurich, London, Amsterdam, and Stockholm;

Asia-Pacific: Melbourne, Adelaide, Brisbane, Canberra, Sydney, Perth, Singapore, Hong Kong, Kuala Lampur, Seoul, Bangkok, Tokyo, and Manila.

4.2 Data Sources

The daily and monthly parking rate was taken from Colliers International, Parking Rate Survey (2008, 2009), and Colliers North America, CBD Parking Rate Survey (2004-2009). The parking rate data of Calgary was also provided by Calgary Transportation and the Calgary Parking Authority. It should be noticed that the data here is at the aggregate level for all of the cities.

GDP per capita and population data were obtained from the following sources:: (i) Demographia: Gross Domestic Product (GDP-PPP) Estimates for metropolitan regions in Western Europe, North America, Japan, and Australasia; (ii) OECD Territorial Reviews (2006).

The data for CBD parking spaces, land size, and CBD employment was drawn from the research by Manville and Shoup (2005), "Parking, people, and Cities" published in Journal of Urban Planning and Development.

The weather information is from Environment Canada, National Weather Service of NOAA, and various sources.

The information on public transit is from: (i) various transit websites; (ii) Metro systems ridership survey; (iii) list of United States rapid transit systems by ridership; and (iv) American Public Transportation Association: Ridership reports.

5. Empirical Results

5.1 Regression Tables

Table 1 records the results of the empirical analysis. In the first two columns of the table, the results from the full sample of 44 observations are recorded. The dependent variables are the logarithm of monthly parking rates and daily parking rates respectively.

Table 1: Factors affecting monthly and daily parking rates – Log linear OLS regression results

	All cities				All excluding US cities	
	Monthly rate (1)	Daily rate (2)	Monthly rate (3)	Daily rate (4)	Monthly rate (5)	Daily rate (6)
Parking spaces	-0.2163317 (-1.10)	-0.209068 (-1.01)	-0.1213882 (-0.62)	-0.125635 (-0.60)	-0.4376066 (-1.87)*	-0.252282 (-1.01)
Employment in CBD	0.1691424 (0.75)	-0.262323 (-1.10)	0.2594936 (1.17)	-0.182926 (-0.77)	0.586506 (1.65)	0.0478122 (0.13)
CBD land size	-0.0935517 (-0.52)	0.0941535 (0.50)	-0.191653 (-1.06)	0.0079453 (0.04)	-0.0522826 (-0.22)	0.0307407 (0.12)
Public transit use rate	0.3301889 (3.12)***	0.3132519 (2.81)***	0.3576961 (3.48)***	0.3374243 (3.06)***	0.3154909 (1.70)	0.1352251 (0.69)
GDP per capita	0.6171776 (2.69)**	0.5696577 (2.35)**	0.5618132 (2.53)**	0.5210053 (2.18)**	0.8038335 (2.59)**	0.8459111 (2.56)**
Metropolitan population	0.1143594 (0.58)	0.5819672 (2.78)***	-0.1253231 (-0.55)	0.371342 (1.53)	-0.3284312 (-1.13)	0.3924205 (1.27)
Urban area size	0.0393041 (0.47)	-0.121290 (-1.36)	0.0215124 (0.26)	-0.136925 (-1.57)	0.2431931 (1.98)*	-0.090688 (-0.69)
Weather	0.0116812 (0.08)	-0.214975 (-1.33)	-0.0031514 (-0.02)	-0.228010 (-1.45)	0.0681838 (0.39)	-0.175325 (-0.95)
Multi-centered dummy	-	-	0.5358443 (1.96)*	0.4708823 (1.61)	-	-
Obs. number	44	44	44	44	32	32
R-squared	0.5807	0.5273	0.6246	0.5617	0.6534	0.5620

Note: numbers in bracket are the t-values of the coefficients. *, **, and *** indicate statistical significance at 10%, 5%, and 1% level respectively.

In column (1), the results show the coefficient of parking spaces per job is negative; it is not statistically significant. CBD land size also has the expected positive sign, which is not significant either. Public transit use rate has a positive coefficient, which is statistically significant at a 1 per cent level. This indicates that higher public transit use is associated with higher monthly parking rates. GDP per capita also has a positive effect on the monthly parking rate, which is significant at 5 per cent level. Other conditions controlled, when GDP per capita in an area increases by 1 per cent, the monthly parking fee in this area tends to increase by 0.62 per cent. Metropolitan population and urban size do not have significant impacts here although their coefficients have the expected signs. The effect of weather on parking rates was found to be statistically insignificant. People living in warmer areas do not tend to walk or bike more to affect the parking price. In column (2), when daily parking rate is used as the dependent variable, the results are similar to what was obtained in column (1). Public transit use rate and the parking rate are positively correlated. GDP per capita tends to increase the daily parking rate significantly. For an increase of 1 per cent, the daily parking rate will increase by 0.57 per cent.

US cities tend to be bigger in area, and have more than one business centers in the metropolitan area. Multi-centered cities have different demands for parking in the CBD areas than uni-centered cities. In columns (5) and (6), the US cities were excluded from the data sample. This leaves 32 observations. The results for GDP per capita are robust, with the coefficients significant in both columns. After excluding US cities, the coefficients for public transit use rate were no longer significant. However, in column (5), the coefficient for parking spaces per job becomes marginally significant. It indicates that, if the ratio of the parking spaces per job in the CBD increases by 1 per cent, the monthly parking rate should decrease by 0.44 per cent.

The results from Table 1 were subjected to a robustness check by using equation 5. The results from the robustness check are show in Table 2. The change of the specification function does not change the robustness of GDP per capita. In all of the six columns of Table 2, positive and statistically significant coefficients for GDP per capita were obtained. When all data in the sample was used in columns (1) and (2), the sign for public transit use rate remained intact and they were all statistically significant. After the multi-centered dummy variable was included in columns (3) and (4), public transit still remained positive for both monthly parking rate and daily parking rate. The coefficient for the multi-centered dummy is marginally significant for the monthly rate. In columns (5) and (6) when US cities are excluded, public transit use rate loses its significance, although GDP per capita still has a positive effect on both rates. It should be noticed that, in column (5) parking spaces has a negative effect on monthly parking rate which is significant at 10 per cent level. It indicates that, if the ratio of parking spaces / employment ratio increases by 10 per cent, the monthly parking rate should decrease by US$ 27.9.

Table 2: Factors affecting monthly and daily parking rates – OLS regression results

	All cities				All excluding US cities	
	Monthly rate (1)	Daily rate (2)	Monthly rate (3)	Daily rate (4)	Monthly rate (5)	Daily rate (6)
Parking spaces per job	-117.3762 (-0.97)	-1.434157 (-0.16)	-107.4354 (-0.94)	-0.6206426 (-0.07)	-279.2266 (-1.82)*	-15.83922 (-1.44)
CBD land size	0.0059815 (0.12)	0.0002738 (0.08)	0.0081309 (0.18)	0.0004497 (0.14)	0.0312374 (0.53)	0.0025612 (0.60)
Public transit use rate	427.5775 (2.45)**	43.29013 (3.34)***	469.6618 (2.85)***	46.73412 (3.89)***	52.65218 (0.21)	15.7495 (0.87)
GDP per capita	5.856186 (2.48)**	0.4198872 (2.39)**	5.455441 (2.45)**	0.3870919 (2.39)**	12.22 (3.22)***	0.9303254 (3.42)***
Metropolitan population	4.43e-06 (0.41)	9.16e-07 (1.13)	-9.55e-06 (-0.81)	-2.28e-07 (-0.27)	1.78e-06 (0.10)	6.55e-07 (0.53)
Urban area size	-0.0010872 (-0.21)	-0.000179 (-0.46)	-0.0038611 (-0.77)	-0.0004061 (-1.11)	-0.0012781 (-0.18)	-0.0000904 (-0.18)
Weather	0.0538526 (0.01)	-0.363085 (-1.10)	-2.040867 (-0.48)	-0.534507 (-1.72)*	0.2425286 (0.05)	-0.4229704 (-1.10)
Multi-centered dummy	-	-	198.9843 (2.41)**	16.28398 (2.71)**	-	-
Obs. number	44	44	44	44	32	32
R-squared	0.7695	0.8069	0.8024	0.8404	0.7888	0.8352

Note: numbers in bracket are the t-values of the coefficients. *, **, and *** indicate statistical significance at 10%, 5%, and 1% level respectively.

6. Impact of Calgary Parking Supply Changes

Based on the information provided by Calgary Transportation, the supply of parking stalls in downtown Calgary should increase by 15 per cent in the next five years [12]. This includes an increase of 12.1 per cent in the downtown core area, and an increase of 27.2 per cent in Beltline area.

Table 3: Price Impact on Parking in Next Five Years in Calgary Downtown

Calgary Parking	Current (stalls)	Next 5 years (stalls)	Increased Parking (%)	Price Impact (%)
Downtown Core	42,252	5,107	12.1%	**5.32%**
Beltline	13,330	3,627	27.2%	**11.97%**
Total Downtown	55,582	8,734	15.7%	**6.91%**

Data sources: Calgary Transportation & Corporate Economics of The City of Calgary, May 2010.

According to the results from the empirical analysis, the increase in the supply of parking spaces by 1 per cent should cause the price of parking to decrease by 0.44 per cent when other conditions are fixed. The negative price elasticity of 0.44 will cause the price of parking in total downtown area to drop by 6.91 per cent on average in the next five years. If we assume the substitution effect of parking in downtown core and beltline is small, and people working in downtown tend to park close instead of in Beltline, then the price impact in the downtown core area is slightly smaller, with a drop around 5.32 per cent in the next five years. Adopting the same assumption of parking substitution effect to the Beltline, we estimate that the price of parking should reduce by 11.97 per cent in the next five years in response to an expected 27 per cent increase in parking.

It should be noted that, the above estimation assumes the downtown area is the only Central Business District of Calgary, and all the other factors impacting the price of parking remain constant during the next five years. If we take into consideration the increase in GDP per capita, the drop in parking price should be less than the impacts listed in the last column of Table 3. However, if Calgary grows into more of a multi-centered city where more business offices and employment are located in suburban areas, the drop in the price of parking should be more than estimated in Table 3.

[12] According to Transportation Planning of The City of Calgary, the increase in the supply of parking will be in place by the end of 2012. Because there is no new development plan starting construction this year based on The City's statistics, the supply of parking stalls in downtown will likely remain stagnant over the next three years after 2012.

7. Conclusions

The price elasticity of parking in the downtown was estimated by controlling for the impact of other factors, and comparing Calgary with international cities. The results show that increasing parking stalls may have a negative effect on the price of parking when a city is uni-centered [13], GDP per capita and transit use in a city have a statistically significant impact on parking. Cities with higher income levels tend to be less responsive to price increases, and cities have higher public transit use rates if the parking costs are more expensive. These results were successfully tested for robustness by using different data sample subsets and equations specification.

When the structure of the city was accounted for, and compare Calgary with other uni-centered cities, we find that the relationship between the number of parking spaces and price becomes significant [14]. For uni-centered cities, when other conditions are fixed, the increase in the supply of parking spaces by 1 per cent should cause the price of parking to decrease by 0.44 per cent.

Next we combine the price elasticity with the estimation that the supply of parking stalls in Downtown Calgary will increase by 15 per cent in the next five years by Calgary Transportation. Assuming other factors remain constant, this increase will cause the price of parking in Downtown to drop by around 7 per cent. If GDP per capita in Calgary grows at a higher rate in the next five years, it is possible that the price reduction would be lower. If Calgary tends to grow into a multi-centered city where business offices and employment are also allocated in suburban areas besides downtown, then the price drop would even be more than expectation.

[13] Calgary is classified in the study as uni-centred.

[14] The new Municipal Development Plan and the Calgary Transportation Plan adopted by Council in 2009 suggest a different structure for the city. In the next 60 years, more centres throughout Calgary will be developed.

8. References

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9. Appendix

Table A1: Bivariate Regressions with Single Independent Variables – OLS Results

Independent Variables	PANEL A Dependent Variable: Monthly Parking Rate			PANEL B Dependent Variable: Monthly Parking Rate		
	Coefficients	Obs. number	R-squared	Coefficients	Obs. number	R-squared
Parking spaces	0.0011543 (1.20)	44	0.0332	0.0000637 (0.86)	44	0.0174
Employment in CBD	0.0001293 (2.00)*	44	0.0866	0.0000102 (2.06)**	44	0.0921
CBD land size	0.0371577 (1.02)	44	0.0243	0.002935 (1.06)	44	0.0260
Public transit use rate	471.5602 (3.23)***	44	0.1989	40.76891 (3.79)***	44	0.2552
GDP per capita	3.158512 (1.10)	44	0.0280	0.0783759 (0.35)	44	0.0030
Metropolitan population	0.0000109 (1.32)	44	0.0397	8.73e-07 (1.38)	44	0.0435
Urban area size	-0.0021846 (-0.45)	44	0.0048	-0.0003844 (-1.05)	44	0.0261
Weather	-2.81969 (-0.55)	44	0.0073	-0.726089 (-1.94)*	44	0.0826
Multi-centered city dummy	109.5619 (1.64)	44	0.0600	6.841615 (1.33)	44	0.0402
US city dummy	-103.4374 (-1.37)	44	0.0425	-10.58438 (-1.86)*	44	0.0765

Note: numbers in bracket are the t-values of the coefficients. *, **, and *** indicate statistical significance at 10%, 5%, and 1% level respectively. Each row of each panel presents the regression results of a regression with a single independent variable. Thus the above table presents the results of 20 regressions respectively.

Table A2: Bivariate Regressions with Single Independent Variables – Log Linear Results

Independent Variables	PANEL A Dependent Variable: Monthly Parking Rate			PANEL B Dependent Variable: Monthly Parking Rate		
	Coefficients	Obs. number	R-squared	Coefficients	Obs. number	R-squared
Parking spaces	-0.0593272 (-0.37)	44	0.0032	-0.0609031 (-0.37)	44	0.0033
Employment in CBD	0.1934978 (1.86)*	44	0.0759	0.1806192 (1.71)*	44	0.0650
CBD land size	-0.0666168 (-0.54)	44	0.0070	-0.0214829 (-0.17)	44	0.0007
Public transit use rate	0.3407042 (4.02)***	44	0.2825	0.287236 (3.24)***	44	0.2037
GDP per capita	0.5509634 (2.77)***	44	0.1546	0.4478527 (2.17)**	44	0.1005
Metropolitan population	0.1513466 (1.39)	44	0.0440	0.1854175 (1.71)*	44	0.0649
Urban area size	0.0528643 (0.75)	44	0.0137	0.0241815 (0.35)	44	0.0029
Weather	-0.1840399 (-1.02)	44	**0.0240**	-0.2745063 (-1.52)	44	0.0524
Multi-centered city dummy	0.2453457 (1.13)	44	0.0296	0.2968538 (1.37)	44	0.0426
US city dummy	-0.1987607 (-0.81)	44	0.0154	-0.3765556 (-1.56)	44	0.0544

Note: numbers in bracket are the t-values of the coefficients. *, **, and *** indicate statistical significance at 10%, 5%, and 1% level respectively. Each row of each panel presents the regression results of a regression with a single independent variable. Thus the above table presents the results of 20 regressions respectively.

Table A3: OLS Regressions with Different Specification Functions

	Monthly rate					Daily rate				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Parking spaces per job	-141.1466 (-1.33)	-93.51527 (-0.87)	-151.868 (-1.320	-84.2334 (-0.73)	-223.985 (-1.97)*	-5.431733 (-0.66)	0.0507446 (0.01)	-12.16546 (-1.40)	-7.53651 (-0.86)	-17.20919 (-1.98)*
CBD land size	0.0402687 (1.03)	0.0095672 (0.23)	-	-	-	0.0032937 (1.08)	-0.000240 (-0.08)	-	-	-
Public transit use rate	493.0637 (3.22)***	559.9291 (3.62)***	427.8156 (2.57)**	527.8304 (3.18)***	209.5417 (1.13)	43.40005 (3.62)***	51.09641 (4.45)***	35.06718 (2.78)***	41.91224 (3.30)***	19.80135 (1.40)
GDP per capita	5.004217 (2.65)**	3.813949 (1.94)*	5.558281 (2.17)**	4.952447 (2.01)*	10.69241 (3.24)***	0.4583185 (3.11)***	0.321316 (2.20)**	0.2738696 (1.42)	0.232406 (1.23)	0.6329446 (2.51)**
Urban density	-0.010043 (-1.81)*	-0.006922 (-1.21)	-	-	-	-0.000306 (-0.71)	0.000053 (0.13)	-	-	-
Weather	3.034471 (0.69)	0.0929998 (0.02)	-	-	-	-0.248026 (-0.72)	-0.586596 (-1.70)*	-	-	-
Multi-centered dummy	-	122.3781 (1.71)*	-	129.0179 (2.15)**	-	-	14.086 (2.65)**	-	8.830045 (1.930*	-
US city dummy	-	-	-	-	-226.6161 (-2.30)**	-	-	-	-	-15.84928 (-2.10)**
Obs. number	44	44	44	44	44	44	44	44	44	44
R-squared	0.7872	0.8032	0.3056	0.3793	0.3883	0.8023	0.8345	0.3190	0.3782	0.3884

Note: numbers in bracket are the t-values of the coefficients. *, **, and *** indicate statistical significance at 10%, 5%, and 1% level respectively.

Table A4: Log Linear Regressions with Different Specification Functions

	Monthly rate					Daily rate				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Parking spaces per job	-0.304424 (-2.40)**	-0.167392 (-1.24)	-0.27109 (-2.49)**	-0.154689 (-1.30)	-0.332193 (-2.94)***	-0.235895 (-1.62)	-0.033710 (-0.23)	-0.24715 (-1.98)*	-0.100051 (-0.74)	-0.350547 (-2.82)***
CBD land size	-0.049294 (-0.50)	-0.133065 (-1.31)	0.255983 (3.14)***	-	-	0.003110 (0.03)	-0.120491 (-1.09)	0.208083 (2.22)**	-	-
Public transit use rate	0.278841 (3.03)***	0.370605 (3.84)***	0.781744 (4.87)***	0.34620 (3.84)***	0.1728113 (1.82)*	0.1676895 (1.59)	0.3030823 (2.88)***	0.665561 (3.61)***	0.3220908 (3.15)***	0.0673413 (0.65)
GDP per capita	0.7128975 (3.77)***	0.5713824 (3.00)***	-	0.6884125 (4.28)***	0.9463058 (5.07)***	0.7001338 (3.23)***	0.4913348 (2.37)**	-	0.5476146 (3.00)***	0.9440281 (4.60)***
Urban density	-0.055558 (-0.69)	-0.015743 (-0.20)	-	-	-	0.061292 (0.67)	0.1200376 (1.41)	-	-	-
Weather	0.0503151 (0.35)	-0.012150 (-0.09)	-	-	-	-0.120345 (-0.72)	-0.212510 (-1.38)	-	-	-
Multi-centered dummy	-	0.4475313 (2.23)**	-	0.355952 (2.03)**	-	-	0.6603118 (3.01)***	-	0.4498267 (2.27)**	-
US city dummy	-	-	-	-	-0.371660 (-1.63)	-	-	-	-	-0.6289152 (-2.51)**
Obs. number	44	44	44	44	44	44	44	44	44	44
R-squared	0.5683	0.6218	0.5582	0.6016	0.5871	0.4255	0.5437	0.4092	0.4796	0.4932

Note: numbers in bracket are the t-values of the coefficients. *, **, and *** indicate statistical significance at 10%, 5%, and 1% level respectively.

Briefing Note - November 2010

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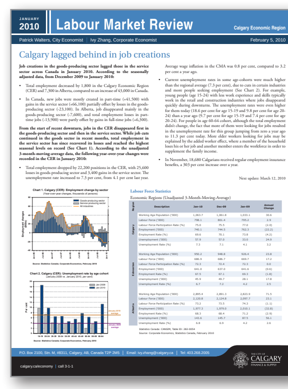

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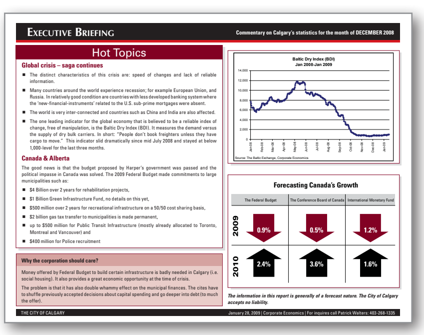

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