STUDY CONTEXT

The cycling mode share for the region of Montreal, as reported in the 2008 *Origine-Destination* (OD) survey, is 1.2% of all trips. This places Montreal's cycling mode share in line with the Canadian national average (Canada, 2010; Pucher & Buehler, 2005). In response to the City of Montreal's 2008 Transportation Plan to increase the cycling mode share in the region, the city intends not only to expand the bicycle path network, but also to improve bicycle parking facilities; specifically by increasing the number of bicycle parking facilities by 500% (Division du Développement des Transports, 2008).

Plans to increase the number of bicycle parking facilities are intended to serve as an incentive to increase active transportation in the region and to prevent bicycle-related crime. According to the *Service de police de la Ville de Montreal* (SPVM), the city's police department, approximately 2,500 bicycles on average are reported stolen every year. The SPVM believes this number represents only a small proportion of all bicycle thefts taking place in the region (Tremblay & Letendre, 2011), with a Montreal bicycle theft committee reporting actual theft numbers in 2011 to be more likely between 15,000 and 30,000 (Riga, 2012).

DATA AND METHODOLOGY

The data used for this study was compiled from the results of a bilingual online survey on bicycle theft that was conducted in the Montreal region. To allow for a broad exposure and reduce sample bias normally associated with online surveys, a variety of measures were taken to ensure a broad cross-section of the public was reached. These measures, as recommended by Dillman, Smyth and Christian (2009) included circulation through a combination of email newsletters, mailing lists, newspaper articles in French and English, a radio interview, and a number of social networking platforms.

The survey yielded a total sample of over 2,039 individuals over a period of approximately one month in the late spring of 2012. This is similar to the number of home-based cycling trips recorded in the regional O-D survey, which samples 5% of the region's population (Agence Metropolitaine de Transport (AMT), 2008). While the survey posited a number of questions relating to bicycle theft, this study uses data only from participants who answered the question, "Would you consider paying for supervised or secured bicycle parking? (i.e., security guard, bicycle locker, bicycle parking garage)." The analysis also used the related socio-demographic information from the survey, including participants' age, gender, income, employment status, and household size. Respondents who left any of these questions blank were removed from the sample. The final sample size used in this study consists of 1,533 Montreal cyclists, of which 43% are willing to pay for secured parking.

As mentioned earlier, this study recognizes that fear of bicycle theft and vandalism can discourage the use of a bicycle for transportation. The study aims to understand whether users are willing to incur some of the extra cost of improving bicycle parking infrastructure improvements, the common characteristics of those who are and are not willing to pay, and whether these characteristics change when an individuals' ability to pay is taken into consideration. Basic socio-demographic information about the survey participants is presented through a series of summary statistics (Table 3). This is followed by a series of logit models. The first model is a binary logit which determines the characteristics associated with whether or not cyclists are willing to pay for secured parking. The second is an ordered logit which takes into account the amount cyclists are willing to pay, and the third is a binary logit that recognizes that WTP differs from ability to pay and only models the data for participants whose household income is high enough to likely offer them the ability to pay for secured parking. The data collected from the survey question, "Would you consider paying for supervised or secured bicycle parking? (i.e., security guard, bicycle locker, bicycle parking garage)" is used for the first and third binary logit models. The results are used to demonstrate which factors most influence survey participants' likeliness to be willing to pay for parking. The second model, which is an ordered logit, uses the results from the question "How much per day?" to determine individuals' willingness to pay. Data for this question is taken from survey respondents' selection from a dropdown menu that had $0.50 as the lowest monetary value, and displayed options at $0.25 intervals, with $50.00 being the maximum. The ordered logit model is used to analyze the variation in cyclists' responses and to better understand which factors influence a cyclist to be willing to pay more for secured parking than others. Finally, to account for the potential discrepancy between WTP and ability to pay, a binary logit is presented that includes only the subset of the sample that has an annual income greater than $60,000. This final model demonstrates that the variables which are significant in the earlier models are consistently significant when only the subset of the sample which is likely to be able to pay for parking is taken into account. The results of this model make clear that WTP in this study is not affected by ability to pay.

SUMMARY STATISTICS

The respondents' ages range from 18 to 85. The average age for cyclists who are willing to pay is 39, and the average for those who are not willing to pay is slightly lower at 36. Women, accounting for 42% of the survey, are slightly overrepresented, compared to O-D survey figures (see Table 3 for more details). Most of the respondents are employed full-time and have completed at least an undergraduate degree. In accordance with the O-D survey, most participants live in two-person households and have a household annual income of between $20,000 and $60,000. Approximately 50% of the participants reported that they had been victims of bicycle theft in their life time, a finding that resembles previous studies (Bachand-Marleau, Lee, et al., 2011).

TABLE 3: SUMMARY STATISTICS

	2012 Bicycle Theft Survey						2008 Origin-Destination Survey (Adult)			
	General		WTP Logit							
	All survey respondents		Willing To Pay		Not Willing to Pay		Bicyclists		All	
GENDER										
Male	58%	(1,037)	63%	(416)	55%	(479)	65%	(1,029)	47%	(58,890)
Female	42%	(738)	37%	(249)	45%	(389)	35%	(548)	53%	(65,563)
AGE										
Average Age	37		39		36		42		48	
18-29	30%	(542)	26%	(175)	31%	(270)	24%	(372)	16%	(19,750)
30-39	37%	(658)	35%	(234)	39%	(342)	22%	(343)	16%	(20,182)
40-49	17%	(301)	17%	(110)	16%	(140)	25%	(395)	21%	(25,929)
50-64	14%	(254)	20%	(130)	11%	(99)	24%	(371)	28%	(34,983)
65+	2%	(41)	2%	(16)	2%	(17)	6%	(96)	19%	(23,609)
HOUSEHOLD SIZE										
One	21%	(369)	20%	(131)	21%	(182)	22%	(346)	15%	(18,203)
Two	43%	(755)	42%	(275)	44%	(379)	34%	(539)	38%	(47,008)
Three	19%	(335)	19%	(129)	19%	(160)	20%	(310)	19%	(24,121)
Four	12%	(213)	13%	(83)	12%	(102)	17%	(270)	19%	(23,788)
Five or More	6%	(100)	7%	(44)	4%	(38)	7%	(112)	9%	(11,333)
OCCUPATION										
Employed	71%	(1263)	80%	(533)	70%	(608)	68%	(1070)	58%	(71544)
Student	21%	(370)	14%	(93)	24%	(207)	13%	(200)	8%	(9,872)
Retired	3%	(50)	3%	(18)	3%	(22)	11%	(181)	25%	(31,057)
Other	6%	(100)	3%	(21)	4%	(31)	8%	(126)	10%	(11,936)
INCOME (household)										
<$20,000	14%	(245)	9%	(59)	16%	(143)	15%	(186)	12%	(10,217)
$20,000 - $60,000	36%	(618)	29%	(192)	40%	(346)	46%	(588)	44%	(38726)
$60,000 - $100,000	26%	(450)	31%	(204)	26%	(225)	26%	(334)	28%	(24688)
>$100,000	23%	(391)	32%	(210)	18%	(154)	13%	(166)	17%	(15,009)
*N**	1,922		665		868		1,577		124,453 (all modes)	

Figure 6 assumes that the majority of cyclists would use free secured bicycle parking (i.e., be willing to pay $0.00), and that 43% would be willing to pay at least $0.50 per day for secured parking. The figure assumes that if a cyclist is willing to pay a given amount, he or she will also be willing to pay lower amounts. The highest amount that participants are WTP is $15.00 (2/1533). Less than 1% of participants is WTP more than $6.00, and is accordingly not included in figure 6. Ideal payments appear to be simple dollar amounts such $1.00 or $2.00. These findings are in accordance with existing paid bicycle parking facilities where long-term secured bicycle parking memberships often average out to well below $1.00 a day, and casual secured

bicycle parking is priced at around $2.00 a day (Bikestation, 2013; City of Toronto, 2013; Sustainable Concordia, 2013; TransLink, 2013).

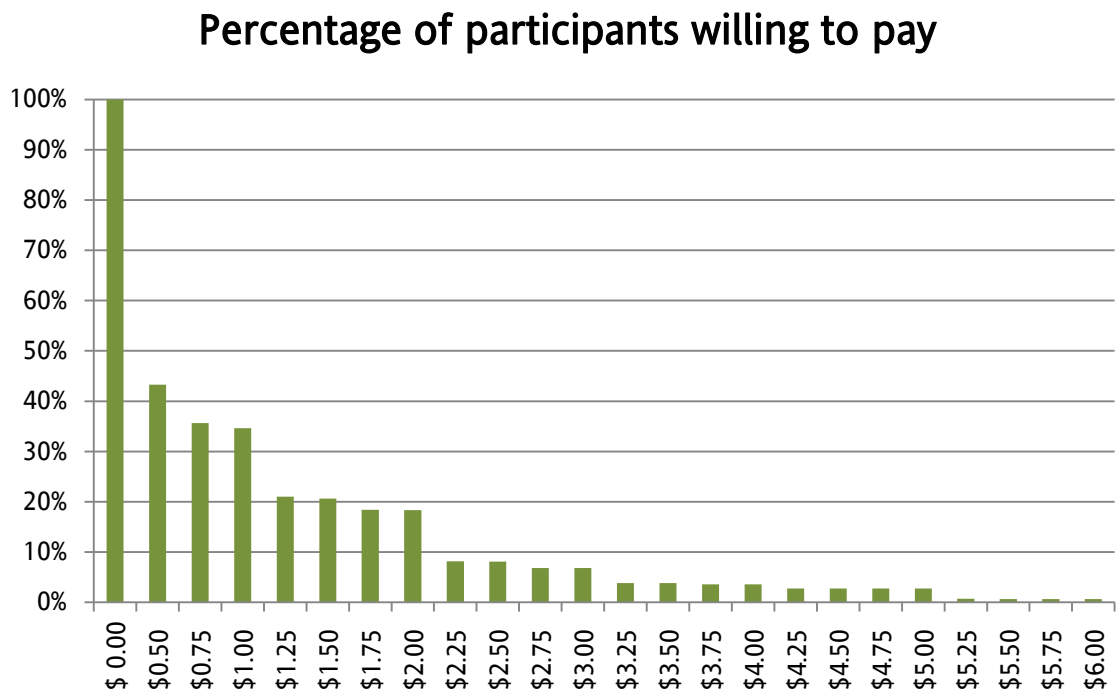

FIGURE 6: SURVEY PARTICIPANTS' WTP PER PRICE CATEGORY

The following section discusses select summary statistics about the variables that may provide information about cyclists' WTP for secured parking. It provides information regarding the sample's cycling habits, theft preventing attitudes, and household income.

Cycling habits

Results from the Montreal Bicycle Theft Survey made clear that when survey participants were asked to rank six different kinds of bicycle parking facilities in terms of safety, secured bicycle lockers were the most favored (van Lierop, et al., 2013). Although many initiatives are being made in North America to make bicycle lockers available for cyclists, other forms of secured bicycle parking are also being implemented (Bikestation, 2013; City of Toronto, 2013; Pratt, et al., 2012; Sustainable Concordia, 2013; TransLink, 2013). According to Transport Canada (2010), the parking and security needs of one cyclist may not be appropriate for all kinds of cyclists. Although Transport Canada (2010) primarily compares commuter cyclists to recreational cyclists, the data from the Montreal Bicycle Theft Survey alternatively enables the categorization of cyclists based on a number of reasons for cycling. Participants ranked different motivations to cycle from 'not at all important' to 'extremely important.' Figure 7 below, shows the results

for cyclists who responded that a given reason was either 'very' or 'extremely' important, and compares the percentage of cyclists in each group who are and who are not willing to pay for secured parking.

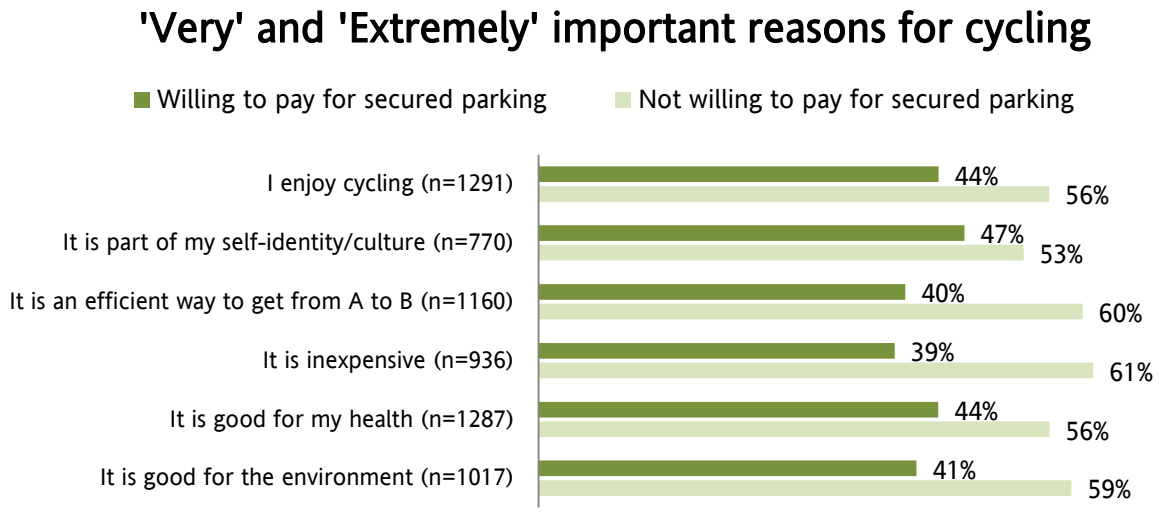

FIGURE 7: DIFFERENCES IN WTP AMONGST SURVEY PARTICIPANTS WHO RANKED REASONS FOR CYCLING AS 'VERY' OR 'EXTREMELY' IMPORTANT

The enjoyment that cyclists experience from riding a bicycle and the health benefits of cycling ranked highest among reasons to cycle. When the χ^2 of these variables was tested with $\alpha = 0.5$ as a criteria for significance, neither the enjoyment of cycling or health reasons were statistically significant. However, in both cases, of the 84% of participants who ranked enjoyment and health benefits as 'very' or 'extremely' important, 44% were willing to pay for secured bicycle parking. Using a bicycle because it is an efficient way to travel was also highly regarded as important (76% 'very' or extremely' important'). This variable was statistically significant with (N=1533) = 18.90, p=0.00. Environmental concern (66%) (N=1533) = 4.37, p=0.04, and, finally, self-identity of a cyclist (50%) (N=1533) = 7.17, p=0.01 were also regarded as being important. Not surprisingly, cyclists who use a bicycle because it is an inexpensive form of transportation have the lowest percentage of cyclists who are willing to pay for secured bicycle parking, (61%) (N=1533) = 17.90, p=0.00. Although only 50% of the total sample strongly identified with bicycle culture, within this subgroup nearly half were willing to pay for secured bicycle parking.

With regards to when participants use a bicycle, results from the survey show that all cyclists in the sample cycle at least one month during the summer. Nearly all cyclists also use a bicycle in spring (98%) and fall (99%), with only 30% of the total sample cycling during at least one of the winter months. This is most likely due to Montreal's harsh winter climate and seasonal bicycle network that significantly reduce winter cycling in the region. While WTP for secured parking is similar for spring, summer, and fall cyclists, it decreases slightly for winter cyclists, although this finding is not statistically significant. This could be because winter

cyclists' higher levels of exposure may have allowed them to become more proficient with bicycle theft prevention practices.

With regards to asking cyclists to state the length of time they feel comfortable cycling, those who were willing to pay for secured bicycle parking were comfortable cycling for an average of 90 minutes (median = 70 minutes), whereas those not willing to pay were comfortable cycling only 79 minutes on average (median= 60 minutes). It is likely that cyclists who are willing to pay for parking on average feel comfortable cycling longer distances because they use their bicycles for commuting, and therefore are more likely to require long-term, secure bicycle parking while they are away from their bicycles.

Theft preventing attitude

Although there has been research conducted on the categorization of different kinds of cyclists (Dill & McNeil, 2013; Geller, 2006), these studies generally do not include cyclists' opinions about theft prevention and bicycle parking. The data from the Montreal Bicycle Theft Survey makes clear that there are two overarching and contrasting techniques to theft prevention. The first method, which is primarily practiced by owners of high value bicycles, is to avoid storing a bicycle in open public places. Owners of higher value bicycles, often keep them inside when they are not being used, and are more likely to be willing to pay for secured bicycle parking. The second technique, which is more common with owners of lower value bicycles, is to use electrical tape, anti-theft rust stickers, spray paint, or decoration to make a bicycle less appealing to thieves. Owners of lower value bicycles are generally not willing to pay for secured bicycle parking, and alternatively often engage in what Adam Thorpe refers to as "fly-parking," a term that is used to describe the securing of bicycles to street furniture not intended to function as parking facilities (Gamman, et al., 2004).

Another way to categorize different kinds of cyclists is by whether or not they have insurance for their bicycle(s). WTP for bicycle parking is clearly reflected in cyclists' WTP for insurance. Figure 8 demonstrates that there are more cyclists who are willing to pay for secured parking and who have insurance than there are cyclists who do not have insurance, do not know whether or not they have insurance, or do not know about bicycle insurance.

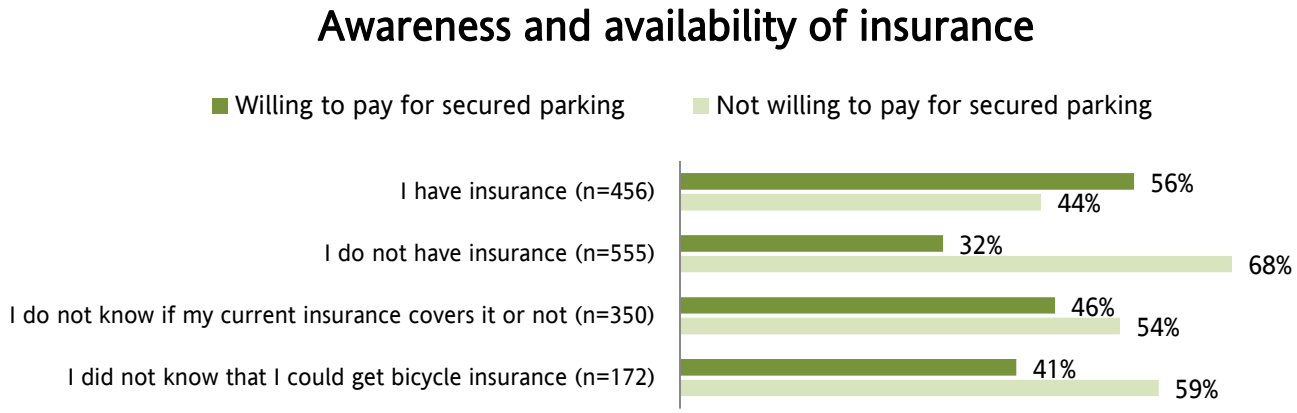

FIGURE 8: DIFFERENCES IN WTP AMONGST SURVEY PARTICIPANTS WHO DO AND DO NOT HAVE INSURANCE FOR THEIR BICYCLE(S)

Household income

The most overwhelming determinant of WTP appears to be household income. A general trend is that as a cyclists' household income increases, so does his or her WTP for secured bicycle parking. Similarly, as the price of an individual's bicycle increases, so does his or her WTP. The equilibrium point in figure 9 shows that cyclists who earn over $60,000 will, in general, more frequently be willing to pay for secured parking. Figure 10 similarly demonstrates the trend that cyclists who own bicycles worth more than $500 are more likely to be willing to pay for parking. These findings are in accordance with the concern that WTP can be influenced by individuals' ability to pay. The differences in participants' WTP and ability to pay are further discussed in the analysis of the third regression below.

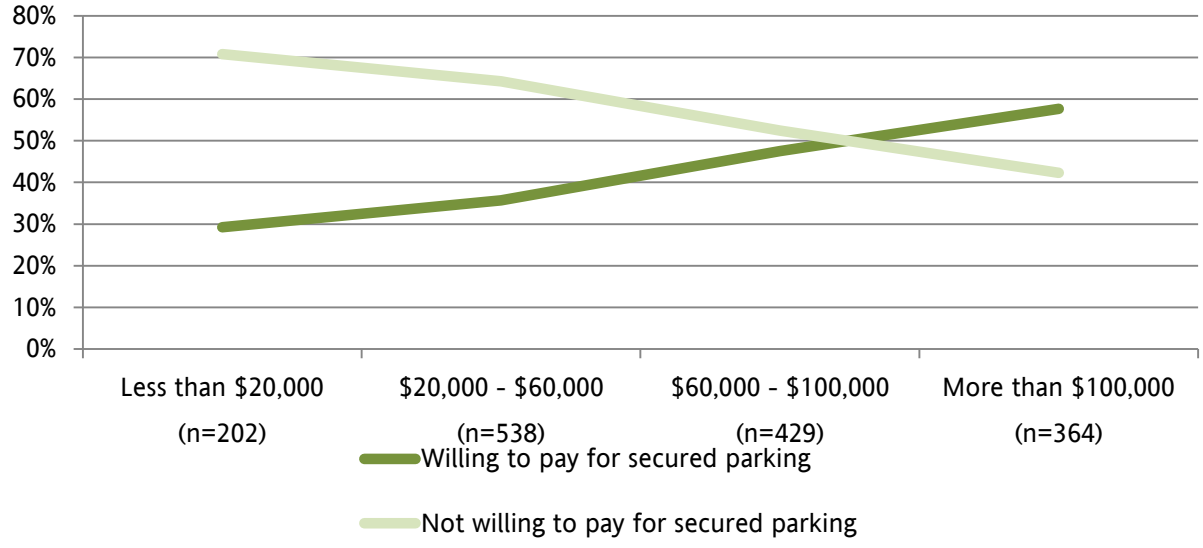

FIGURE 9: DIFFERENCES IN WTP BASED ON ANNUAL INCOME

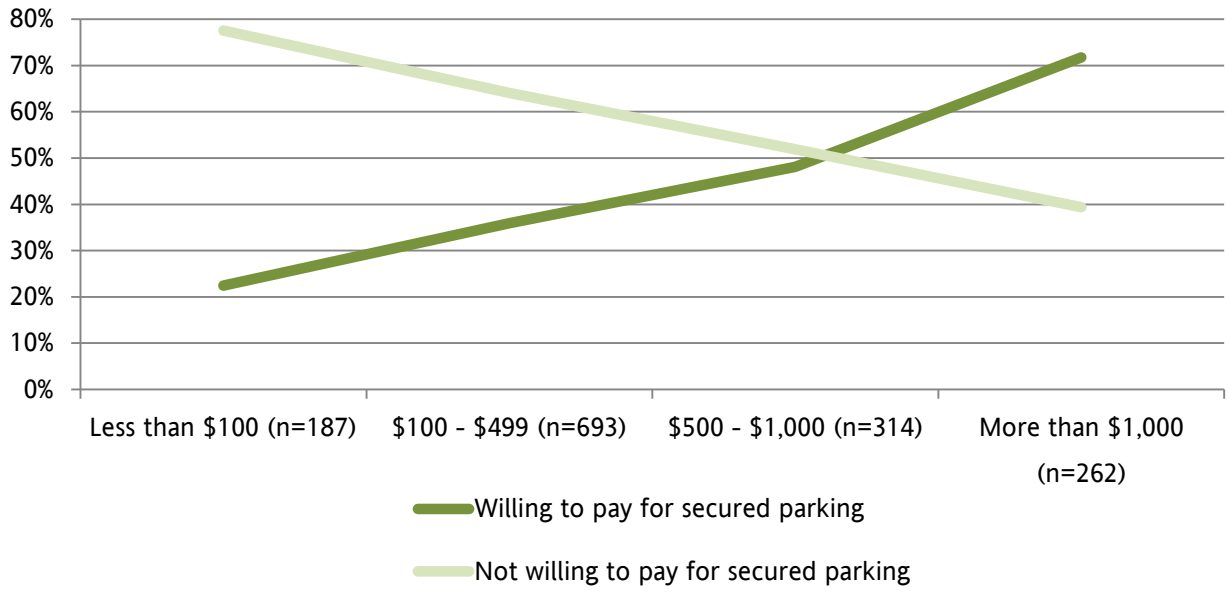

FIGURE 10: DIFFERENCES IN WTP BASED ON THE PRICE OF CYCLISTS' CURRENT BICYCLE

DETERMINANTS OF WTP

The following section uses a series of logit models to better understand cyclists' WTP for secured bicycle parking. First, a binary logit is used to demonstrate which factors most influence cyclists to be willing to pay for secured bicycle parking. The second model is an ordinal logit that demonstrates which factors are more likely to influence a cyclist to be willing to pay either $0.00, $0.50-$1.00, $1.25-$2.00, or more than $2.00 a day for secured bicycle parking. The third model, which accounts for cyclists' ability to pay for secured bicycle parking, is a binary logit which includes only the survey respondents with annual incomes of $60,000 or higher. This threshold is based on the finding from figure 9, which makes clear that cyclists' whose annual income is $60,000 or greater are more likely to be willing to pay for secured bicycle parking, and therefore also more likely to be able to pay than lower income cyclists. WTP for cyclists with incomes $60,000 or more is therefore less likely to be influenced by ability to pay than for lower income cyclists.

Choice of variables

A correlation matrix was used to choose appropriate variables for the models. Variables included individuals' habits, choices, and socio-demographic statuses. Many variables pertaining to monetary values such as 'insurance' and 'lock price' were not included because they were highly correlated with the 'income' variable. Other variables were not included because they did not show significance. Surprisingly, having been a victim of bicycle theft did not affect a cyclists' likeliness to be willing to pay for parking; this variable

was insignificant in the primary models and was, therefore, not included in the final ones. The variable 'bicycle value' was included in the model to demonstrate that it is not only how much cyclists earn that effects WTP, but also the amount that cyclists are willing to spend on a bicycle. Relevant literature was also consulted to decide which variables should be used. For example, Jou, Chiou et al.'s (2012) study includes socio-demographic, trip frequency, and WTP information. These authors included gender, age, education, occupation, working hours, and monthly income to measure socio-demographic information. Other authors also included similar variables to better understand WTP (Anastasiadou, et al., 2009; dell'Olio, et al., 2011; O'Garra, et al., 2007; Russo, et al., 2012).

The logit models below include socio-demographic information about cyclists' employment status, gender, age, and income. The employment statuses 'retired' and 'other', although not statistically significant, are kept in the model in accordance with the relevant literature which commonly accounts for participants' employment or work status. Gender, although also insignificant, is included for the models to be theoretically consistent with the relevant literature. Cyclists' level of education is not included in the models because it was highly correlated with both employment status and income. Because the data from the Montreal Bicycle Theft Survey does not provide information about the distances cyclists commute, the continuous variable 'time comfortable' is included. This variable describes the distance that cyclists are comfortable cycling. The model also includes the continuous variable 'commute,' which determines the number of years that a cyclist has been using a bicycle to commute. Few studies include information about participants' attitudes towards statements; O'Garra, Mourato et al. (2007), for example, include a variable in their regression that measures participants' attitude to environmental problems. Figure 7 shows the questions included in the Montreal Bicycle Theft Survey that considered cyclists reasons for using a bicycle. All of the reasons for cycling were tested in the preliminary models, but only the variable 'culture' which represents the statement, "It is part of my self-identity/culture" was found to be statistically significant in the logistic regressions. This variable was therefore kept in the model while other reasons for cycling were taken out.

Binary Logit

The model possesses a reasonable amount of explanatory power (Cox & Snell R square = 0.16, Nalgelkerke R square =0.22), and its variable coefficients all have the expected positive or negative signs. The model uses WTP for secured bicycle parking as the dependent variable and indicates that risk of theft, employment status, age, income, cultural identity as a cyclist, the amount of years that a cyclist has been commuting, and the value of the bicycle, are statistically significant.

TABLE 4: BINARY LOGIT (ALL PARTICIPANTS)

Parameters		Coefficient		t-stat	Odds Ratio
Theft influence:	Slight	.633	***	4.510	1.883
	Moderate	1.073	***	6.538	2.923
	Very	1.564	***	7.431	4.779
	Extremely	2.133	***	6.550	8.437
Employment status:	Student	-.342	*	-1.934	0.711
	Retired	-.579		-1.492	0.561
	Other	.175		.553	1.191
Gender:	Male	.100		.840	1.105
Age:	Age	.016	***	2.604	1.016
Annual household income:	Less than $20,000	-.680	***	-3.003	0.507
	Between $20,000 - $60,000	-.714	***	-4.553	0.489
	Between $60,000 - $100,000	-.365	**	-2.340	0.694
Reason:	Culture	-.437	***	-3.597	0.646
Commuting:	Time comfortable	.002		1.610	1.002
	Years commuting	-.065	***	-3.978	0.937
Cost of bicycle:	Low (less than $500)	-.684	***	-5.717	0.504
Constant:		-.210		-0.622	0.811

Cox & Snell R Square = 0.162
Nagelkerke R Square = 0.218
N=1533

*** 99% significance
** 95% significance
* 90% significance

In this first binary logit model, the variable 'Theft' is highly significant meaning that the greater the influence of risk of theft has on a cyclist's decision to use a bicycle, the more likely a cyclist is willing to pay for secured parking. The model compares cyclists' decision to cycle to be slightly, moderately, very, or extremely influenced by the risk of bicycle theft to those who are not at all influenced. Whereas WTP for cyclists who are slightly influenced by the risk of theft increases only by 88%, WTP for cyclists whose decisions to use a bicycle are extremely influenced by theft increase by 744% compared to cyclists whose decision to use a bicycle is not at all influenced. Not surprisingly, students' WTP decreases by 29% compared to participants who are in the work force and are also less likely to be willing to pay than other cyclists. Similarly, younger cyclists are less likely to be willing to pay. With regard to annual household income, cyclists who have an annual income lower than $60,000 are approximately 50% less likely to be willing to pay for secured parking, and cyclists who earn between $60,000 and $100,000 are 31% less likely to be

willing to pay than are cyclists whose annual income is greater than $100,000. Similarly, cyclists who own low-value bicycles (under $500) are only half as likely to be willing to pay as are cyclists with bicycles valued at over $500. The amount of time that a cyclist is comfortable using a bicycle is insignificant, while as the amount of years that a participant has been commuting by bicycle increases, their likeliness to be willing to pay for parking decreases. This may be due to cyclists' increased level of exposure having led to long-term commuters becoming more aware of bicycle theft prevention strategies. This finding mirrors the summary statistic that year-round cyclists are less likely willing to pay for secured parking. Cyclists who did not report that culture was a very or extremely important reason for using a bicycle were also 35% less likely to willing to pay for secured bicycle parking than cyclists who identified more closely with cycling culture.

Ordered Logit

The results of the ordered logit are similar to those of the binary logit. In this model, the dependent variables are the amounts that cyclists are willing to pay for parking. The first group (n=869) contains cyclists who are willing to pay zero dollars (not willing to pay). The second group (n=342), represents cyclists who are willing to pay between $0.50-$1.00, the third (n=197), $1.25-$2.00, and the fourth (n=125), cyclists who are willing to pay more than $2.00 a day for secured bicycle parking. These categories were chosen because they represent the ideal rates represented in figure 6, and because they correspond to the abovementioned existing paid bicycle parking facilities.