ARE THE TRANSIT FARES FAIR?

Public transit fare structure and social vulnerability in Montreal, Canada

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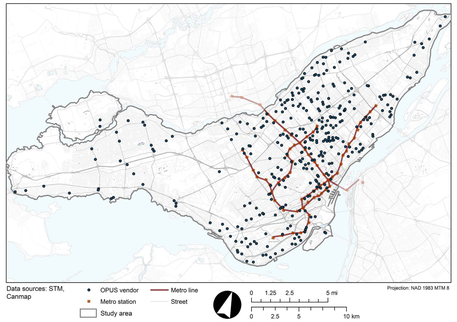
ABSTRACT

- Little is known about how public transit fare structure affects social equity. Some transit agencies charge more for fewer rides; often weekly fares cost more per ride than unlimited monthly passes
- For low income earners, purchasing weekly passes might be attractive for the low up-front costs, since monthly passes may be too large of a financial burden
- We analyzed transit pass purchases of total monthly, weekly, and three or more weekly passes during the month of September 2014 in Montreal, Canada
- We discovered that household income and a measure of social vulnerability are associated with greater purchases of weekly passes compared to monthly passes
- We found that recurring purchases of three or more weekly passes depend on income and a social indicator of the neighborhood
- Our findings indicate that individuals residing in vulnerable neighborhoods are likely to spend more money on transit fares over the course of a month compared to those residing in better-off neighborhoods

METHODOLOGY

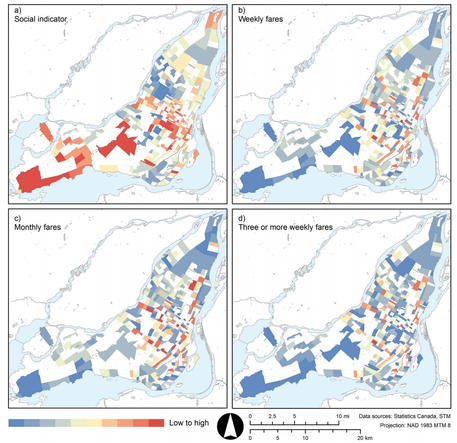
- We extracted fare sales from September 2014 for adult fares of monthly ($79.50 CAD) and weekly ($24.50 CAD) passes from smart card transaction records
- Unit of analysis (see map *points of sale*): 407 points of sale, including 64 metro/transit stations + 343 vendors
- Network buffer of 1 km around transit station
  Network buffer of 500 m around vendor
- Social indicator (normalized *z* score) from 2011 Census data intersected with buffer and weighted by area:
  - median household income
  - percent of unemployed residents
  - percent of recent immigrants
  - percent of residents with a high school diploma only
  - percent of low-skill workers

POINTS OF SALE



This map shows points of sale across the Island of Montreal, the major territory of the STM. The metro network including stations is also shown since fares are sold at stations. Fares sold at stations off the Island are not included in the analyses.

SOCIAL INDICATOR & FARE SALES



Deprived neighborhoods are located mostly in eastern Montreal as well as in the southwest. Many of these deprived neighborhoods (bluer colors in a) purchase more of all types of fares, including costlier weekly passes.

DESCRIPTIVE STATISTICS

Variable name	Description	Mean	Std. Dev.
Income	Household median income (Canadian dollars) within the buffer divided by $1,000	45.02	14.39
Social indicator	Combined z-score of a social indicator comprised of z-scores of household median income, percent of unemployed residents, percent of recent immigrants, percent of residents with a high school diploma only, and percent of low-skill workers within the buffer	-1.37	2.84
Distance to CBD	Network distance (km) from vendor or metro station to downtown center point	9.62	6.00
Distance to CBD^2	Square-term of network distance to downtown	128.39	168.62
Metro (dummy)	Dummy variable equal to 1 if the point of sale is a metro station	0.15	0.36
Hub (dummy)	Dummy variable equal to 1 if the metro station is a major transfer station or main downtown station	0.037	0.19
Metro stations	Number of metro stations located within the buffer (excluding the metro station that is the vendor)	0.34	0.82
Bus stops	Number of bus stops located within the buffer	25.59	26.87
Commuter stations	Number of commuter stations located within the buffer	0.057	0.26
Other vendor (dummy)	Dummy variable equal to 1 if a vendor (non-metro) is located within the buffer	0.56	0.50
Dependent variable			
Total weekly fares	Total weekly fares (calendar weeks 36, 37, 38, 39 and 40) sold in the month of September	233.05	386.16
ln of total weekly fares	Natural logarithm of total weekly fares (calendar weeks 36, 37, 38, 39 and 40) sold in the month of September	4.35	1.63
Total monthly fares	Total monthly fares (September and October) sold in the month of September	486.69	897.27
ln of total monthly fares	Natural logarithm of total monthly fares (September and October) sold in the month of September	4.91	1.61
IDs 3 or more	Number of unique OPUS IDs purchasing 3 or more weekly fares at unique points of sale	13.26	21.21
ln of IDs 3 or more	Natural logarithm of number of unique OPUS IDs purchasing 3 or more weekly fares at unique points of sale	1.87	1.26

WEEKLY MODEL

	Model 1a		*Model 1b*	
Variable	**Coefficient**	**z-statistic**	**Coefficient**	**z-statistic**
Income	**-0.020****	**-3.95**	–	–
Social indicator	–	–	**-0.15****	**-6.80**
Distance to CBD	**0.29****	**8.80**	**0.20****	**5.68**
Distance to CBD^2	**-0.0084****	**-7.07**	**-0.0060****	**-5.00**
Metro (dummy)	**2.34****	**6.45**	**2.19****	**6.32**
Hub (dummy)	0.44	1.40	0.42	1.36
Metro stations	-0.20	-1.53	-0.22	-1.79
Bus stops	**0.020****	**3.22**	**0.023****	**3.75**
Commuter stations	0.045	0.18	0.036	0.15
Other vendor (dummy)	-0.065	-0.52	-0.10	-0.85
Constant	**2.71****	**7.97**	**2.18****	**9.20**
Random-effects parameters	Estimate	Std. Error	95% confidence interval	
Canadian census tract: Identity				
Model 1a				
sd (constant)	0.52	0.10	0.36	0.76
sd (residual)	0.98	0.055	0.88	1.09
Model 1b				
sd (constant)	0.42	0.11	0.25	0.71
sd (residual)	0.97	0.053	0.88	1.09

Bold indicates statistical significance; ** Significant at 99%; * Significant at 95%

- Intraclass correlation coefficient (rho) statistic:
  Model 1a 22.0% Model 1b 15.8%
- For a $10,000 increase in income, 20% fewer weekly passes are sold
- For every unit increase in the social indicator (less deprivation), 15% fewer weekly passes are sold

MONTHLY MODEL

	Model 2a		*Model 2b*	
Variable	**Coefficient**	**z-statistic**	**Coefficient**	**z-statistic**
Income	0.00093	0.19	–	–
Social indicator	–	–	**-0.059****	**-2.62**
Distance to CBD	**0.13****	**3.94**	**0.080***	**2.27**
Distance to CBD^2	**-0.0040****	**-3.46**	-0.0023	-1.94
Metro (dummy)	**2.55****	**7.14**	**2.54****	**7.28**
Hub (dummy)	0.56	1.72	0.53	1.64
Metro stations	-0.078	-0.62	-0.11	-0.84
Bus stops	**0.015***	**2.35**	**0.015***	**2.46**
Commuter stations	-0.24	-0.25	-0.13	-0.56
Other vendor (dummy)	-0.077	-0.63	-0.11	-0.88
Constant	**3.45****	**10.40**	**3.66****	**15.34**
Random-effects parameters	Estimate	Std. Error	95% confidence interval	
Canadian census tract: Identity				
Model 2a				
sd (constant)	0.30	0.16	0.10	0.85
sd (residual)	1.05	0.056	0.95	1.17
Model 2b				
sd (constant)	0.21	0.23	0.022	1.92
sd (residual)	1.07	0.057	0.96	1.19

Bold indicates statistical significance; ** Significant at 99%; * Significant at 95%

- Intraclass correlation coefficient (rho) statistic:
  Model 2a 7.5% Model 2b 3.7%
- Income is not a statistically significant predictor of monthly pass sales
- For every unit increase in the social indicator (less deprivation), 6% fewer monthly passes are sold

RECURRING WEEKLY MODEL

	Model 3a		*Model 3b*	
Variable	**Coefficient**	**z-statistic**	**Coefficient**	**z-statistic**
Income	**-0.017****	**-4.47**	–	–
Social indicator	–	–	**-0.13****	**-7.63**
Distance to CBD	**0.22****	**8.50**	**0.14****	**5.16**
Distance to CBD^2	**-0.0058****	**-6.52**	**-0.0038****	**-4.31**
Metro (dummy)	**2.19****	**8.03**	**2.05***	**7.96**
Hub (dummy)	0.32	1.35	0.31	1.32
Metro stations	**-0.30****	**-3.15**	**-0.32****	**-3.44**
Bus stops	**0.013****	**2.64**	**0.015****	**3.27**
Commuter stations	-0.067	-0.36	-0.081	-0.46
Other vendor (dummy)	-0.0085	-0.09	-0.041	-0.47
Constant	**0.78****	**3.05**	0.32	1.83
Random-effects parameters	Estimate	Std. Error	95% confidence interval	
Canadian census tract: Identity				
Model 3a				
sd (constant)	0.35	0.080	0.23	0.55
sd (residual)	0.75	0.041	0.68	0.84
Model 3b				
sd (constant)	0.26	0.094	0.13	0.53
sd (residual)	0.75	0.039	0.68	0.83

Bold indicates statistical significance; ** Significant at 99%; * Significant at 95%

- Intraclass correlation coefficient (rho) statistic:
  Model 3a 17.9% Model 3b 10.7%
- For a $10,000 increase in income, 17% fewer riders will buy 3 or more weekly passes
- For every unit increase in the social indicator (less deprivation), 13% fewer riders will buy 3 or more weekly passes

CONCLUSIONS

Decreasing income predicts greater weekly fare sales and recurring weekly fare sales

Increased social deprivation predicts greater weekly fare sales, recurring weekly fare sales, and monthly fare sales

Weekly fares therefore burden marginalized residents more than residents in wealthier neighborhoods

RECOMMENDATIONS

Transit agencies should reconsider pricing of weekly vs. monthly fares

Refunds or reduced monthly fares for low-income individuals could help address equity concerns

Future studies should investigate purchase behavior with surveys as well as demographic data linked to smart cards

Photo credit: Montreal Gazette

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