The Spatial Patterns Affecting Home to Work Distances of Two-Worker Households

Julien Surprenant-Legault, Master of Urban Planning Candidate
School of Urban Planning, McGill University

Ahmed El-Geneidy, Assistant Professor
School of Urban Planning, McGill University

ABSTRACT

Round-trips between home and work represent, for the majority of North Americans, most of their daily commuting time; also, selecting home and work places involves more constraints for two- than for one-worker households. This research aims at providing some of the information missing on the location decisions of two-worker households to improve land use and transportation policies. In order to explain home to work distances for two-worker households, three logarithmic regression models are built: the first including workers in one- and two-worker households, the second with workers in two-worker households only, and the third one estimating the sum of distances in two-worker households. This last model includes spatial interrelationship factors, that are the ratio of the minimal over the maximal accessibility to jobs by car within 15 minutes between the two workplaces, the ratio of the minimal over the maximal Euclidean home to work distance, and the angle formed at home location by the direct lines linking each workplace to home. Results show that even though members of two-worker households travel on average longer distances than one-worker-household members, they develop strategies to minimize distances, as locating one of the workplaces near home. Moreover, *workplace 1-home-workplace 2* angles are smaller in the suburbs to profit from major transportation infrastructures and bigger in the centre where an efficient grid transportation network exists. This research could help policy makers adapt land use and transportation networks to the needs of a growing population group.

INTRODUCTION

Selecting home and work places involves more constraints for two- than for one-worker households and necessitates compromises within households (Costa & Kahn, 2000; Green, 1997; Sultana, 2005; van Ommeren, 2000). As Clark, Huang, and Withers noted, "it is clear that there is a dearth of research addressing the spatial complexity of dual-earner households, yet economic, social, and spatial restructuring indicate the continued dominance of this household type for the foreseeable future" (2003, p. 218). In Montréal, Québec, Canada, two-worker households represented 19.8% of households and 43.6% of workers in 2003.

This research aims at providing some of the information missing in the location decisions of this important population group in order to better optimize transportation networks, which means a better matching of offers with demands. It also aims at identifying the geometrical norms in the triangle formed by the home and the two workplaces. Understanding how location choices are interrelated in two-worker households is useful in implementing land use and transportation policies seeking to correspond to and sometimes modify travel behaviour.

METHODOLOGY

As of 2008, the Montréal Metropolitan region comprises 3.75 million inhabitants. The region's centre is strong by its demographic weight, with 1.6 million people in the city of Montréal, while all employment sectors are close to the centre.

The data used in this research comes from the AMT 2003 Origin-Destination (O-D) survey (Agence métropolitaine de transport, 2003). The AMT O-D survey is a comprehensive travel behaviour survey covering 4.70% of all residents in the Montréal Metropolitan region living in 56,959 households. The data were refined to obtain 11,271 two-worker households as well as 20,725 one-worker households used as a comparison group.

The distance linking a household's home to one of its workplaces is the dependant variable in the logarithmic regression models.

ANALYSIS AND DISCUSSION

Table 1 presents the descriptive statistics for the variables used in the regression models explaining home to work distances. In Montréal, workers living in two-worker households travel longer distances than workers living in one-worker households.

Variable	Workers in One-Worker Households Median	Mean	Std. Dev.	Workers in Two-Worker Households Median	Mean	Std. Dev.
Home to Work Euclidean Distance (m)	8,533	11,445	10,282	9,702	12,304	10,328
Sum of Home to Work Euclidean Distances (m)				21,061	24,609	16,921
Home to Work Network Distance (m)	11,019	14,309	12,199	12,546	15,404	12,259
Circuity	1.2551	1.2935	0.2324	1.2574	1.3021	0.2742
Combined Circuity of the Household				1.2577	1.2857	0.1653
Age	42	42	11	41	41	10
Accessibility to Jobs at Home	62,515	104,071	106,597	45,083	84,638	94,685
Accessibility to Jobs at Workplace	171,882	204,128	158,498	156,859	194,307	156,285
Ratio of the Minimal over the Maximal Accessibility to Jobs by Car within 15 Minutes at Workplace				0.5180	0.5358	0.3268
Ratio of the Minimal over the Maximal Euclidean Home to Work Distance				0.5801	0.5665	0.3191
Angle at Home Location (°)				34.2	52.8	52.7

Variable	Proportion	Proportion
Female	43.3%	49.3%
Household Income		
[$0 – $20,000[	10.1%	2.8%
[$20,000 – $40,000[	31.8%	15.3%
[$40,000 – $60,000[	26.4%	24.7%
[$60,000 – $80,000[	14.8%	23.2%
[$80,000 and above	16.9%	34.1%
Trip Mode		
Auto Driver	68.1%	70.9%
Auto Passenger	4.4%	7.5%
Public Transit	18.6%	14.0%
Auto and Transit	2.6%	3.1%

Table 1: Descriptive Statistics for the Variables Used in the Regression Models

Figure 1 is a cluster and outlier analysis of the *workplace 1-home-workplace 2* angle that reveals clusters and outliers of high or low values. Anselin Local Moran's I statistic for spatial autocorrelation calculates spatial correlation by taking into account the values of features and their location relative to each other. In the case of angles, the higher the value, the more opposite are the directions that partners take to reach their jobs. Clusters of high values are concentrated in the central part of the Island of Montréal, extending to Longueuil and Laval, and in Saint-Jérôme and Saint-Jean-sur-Richelieu, while clusters of low values are frequent around the centre of the Island of Montréal. This pattern could be explained by a high job accessibility by any mode for houses located in the centre. The repetition of the pattern to Saint-Jérôme and Saint-Jean-sur-Richelieu could signify that these cities still act as local centres and are not dependent on jobs found on the Island of Montréal.

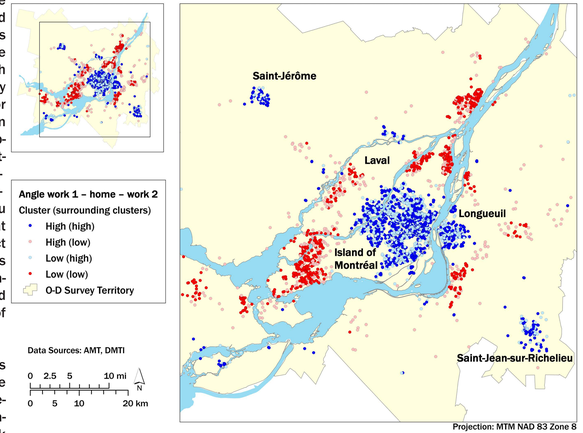

Figure 1: High- and Low-Value Clusters and Outliers of the Workplace 1 – Home – Workplace 2 Angle

Table 2 introduces the results of the two logarithmic regressions explaining home to work distances. As Plaut postulates (2006), the results for Montréal indicate a positive effect of the distance travelled by the partner on the other's journey to work; in this case, when the partner's distance raises by 1%, the other's distance increases by 0.16%. This is likely due to home location that offers less accessibility to jobs for both partners (see Table 1). Each member of a two-worker household travels 2.31% less to go to work when compared to a worker in a single-earner household, everything else kept equal.

The last logarithmic regression presented in Table 3 concerns the sum of home to work Euclidean distances in a household and adds spatial interrelationship factors (in bold, all significant at 99.9%). These factors give a higher explanatory power (R^2) to regression 3 compared to regression 2, which means that two-worker households tend to at least partially pool their commuting distances, and try to minimize the sum of distances subject to their household's constraints.

The first factor, the ratio of the minimal over the maximal accessibility to jobs by car within 15 minutes at workplace, varies between 0 and 1 and has an average of 0.5358. Thus, on average, this ratio decreases the sum of distances by 37.5%, but when the partners have the same accessibility to jobs at workplace, their distance decreases instead by 70.0%, 32.5% more. This strong impact is due to the seemingly different effects of maximal and minimal accessibility to jobs at work location. The ratio may be higher when the partners work close to one another, increasing the degree of attraction of the set of workplaces and the willingness to pay for housing. The ratio of the minimal over the maximal Euclidean home to work distance increases the sum of distances travelled by 17.8% when it is equal to its average of 0.5665. The increase can go up to 31.5% (13.7% more) when the distances travelled are identical. *Ceteris paribus*, households where partners travel different distances exhibit a smaller sum of distances, probably because one of the partners travels less than his or her willingness to travel. Furthermore, the workplace 1-home-workplace 2 angle makes the sum of distances decrease by 0.09% when it increases by 1%. As the transportation network tends to ease trips directed towards the CBD (Vandersmissen et al., 2003), it is possible that workers living away from the centre would locate their home and the two workplaces near a major transportation axis, creating a small angle. Here, a small angle is the result of a strategy attempting to minimize the sum of distances when this sum is already large. On the contrary, when people work and live near the CBD, the transportation network is dense enough to allow movement in many directions at an acceptable speed. In the two cases, the angle gives a sense of the possibilities that land use patterns and transportation networks offer to workers in terms of residence and work location. Moreover, clusters of angles shown in Figure 1 support this hypothesis. Hence, two-worker-household members may shrink their commuting distances by applying strategies that involve adjusting their home to work distances to one another's.

	(1) Workers in One- or Two-Worker Households Coefficient	t	(2) Workers in Two-Worker Households Coefficient	t
Constant	7.972548	91.44 ***	6.256956	56.9 ***
Ln of Circuity	-1.159587	-35.55 ***	-1.134283	-26.77 ***
Two-Worker Household	-0.0230914	-2.34 *		
***Ln* of Partner's Home to Work Distance**			**0.1621471**	**26.32 *** **
Female	-0.1871213	-19.7 ***	-0.2295368	-17.93 ***
Age	0.0117437	3.97 ***	-0.0032025	-5.03 ***
Age Squared	-0.000187	-5.34 ***		
Household Income				
[$0 – $20,000[	-0.2347914	-10.97 ***	-0.1017565	-2.55 *
[$20,000 – $40,000[	-0.0759968	-5.61 ***	-0.0646066	-3.17 **
[$60,000 – $80,000[	0.0812501	5.75 ***	0.0795304	4.4 ***
[$80,000 and above	0.0981365	7.42 ***	0.0812057	4.85 ***
Trip Mode				
Auto Driver	1.691885	78.23 ***	1.683308	53.53 ***
Auto Passenger	1.465916	52.04 ***	1.496266	39.4 ***
Public Transit	1.516783	64.79 ***	1.508659	43.95 ***
Auto and Transit	1.901319	54.57 ***	1.846075	39.18 ***
Ln of Accessibility to Jobs				
At Home	-0.3035778	-72.68 ***	-0.2671164	-45.98 ***
At Workplace	0.2481991	53.51 ***	0.2607946	42.45 ***
	N 34,589		N 18,070	
	R^2 0.3573		R^2 0.3776	
	Adj. R^2 0.3571		Adj. R^2 0.3771	

*** Significant at 99.9%
** Significant at 99%
* Significant at 95%

Table 2: Logarithmic Regression Models 1 & 2 – Home to Work Euclidean Distance

	Coefficient	t
Constant	10.18461	87.54 ***
Ln of Combined Circuity of the Household	-0.9764056	-17.11 ***
Mean Age of the Two Workers	-0.0023975	-3.67 ***
Household Income		
[$0 – $20,000[	-0.0502723	-1.29
[$20,000 – $40,000[	-0.0283186	-1.43
[$60,000 – $80,000[	0.0917877	5.34 ***
[$80,000 and above	0.0733069	4.54 ***
Trip Mode (1 for Each Worker)		
Auto Driver	0.5355996	26.54 ***
Auto Passenger	0.3865787	14.83 ***
Public Transit	0.3912148	17.9 ***
Auto and Transit	0.5509077	18.51 ***
Ln of Accessibility to Jobs at Home	-0.2117275	-33.96 ***
Ln of Maximal Accessibility to Jobs within 15 Minutes of Each Workplace	0.1448001	16.36 ***
Ratio Min/Max Accessibility to Jobs at Workplace	-0.7003689	-26.2 ***
Ratio Min/Max Home to Work Euclidean Distances	0.3145576	13.06 ***
Ln of Angle at Home Location	-0.0905096	-16.65 ***
	N 7,915	
	R^2 0.4804	
	Adj. R^2 0.4794	

Table 3: Logarithmic Regression Model 3 – Sum of Home to Work Euclidean Distances in Two-Worker Households

CONCLUSIONS AND RECOMMENDATIONS

The models support the conception that home to work distance is influenced by variables representing the interrelationships in two-worker households' home and work location choices. In Montréal, all other variables kept equal, workers in two-worker households travel 2.31% less than workers in one-worker households. Two-worker households adopt strategies to minimize the sum of home to work distances. These strategies are working in milieus with similar accessibility to jobs, which eases the selection of a location close to home; locating home and one of the work locations near one another; or travelling to work in the same direction following major transportation axes, especially when distances to travel are already long.

Observed patterns in the angles can be used to define areas for improvements in the public transit network. For instance, in the heart of the Island of Montréal the grid-like transit system could be reinforced to serve commuters more efficiently. Meanwhile, a high-capacity east-west transit corridor on the Island as well as high occupancy vehicle lanes can help in getting two-worker-household workers to their destinations. In addition, a good land use mix providing jobs near residences could be effective in decreasing distances travelled, as strategies adopted by two-worker households already indicate that they seek to locate at least one of the workplaces close to home.

ACKNOWLEDGEMENTS

We would like to gratefully thank Daniel Bergeron, from the Agence métropolitaine de transport, Assumpta Cerdá, Paul Lewis, and our funders, the Natural Sciences and Engineering Research Council of Canada and the Social Sciences and Humanities Research Council of Canada.

TRANSPORTATION RESEARCH BOARD ANNUAL MEETING
WASHINGTON, D.C.
JANUARY 13, 2010

CIRRELT
TRAM TRANSPORTATION RESEARCH AT McGill
McGill