JOB LOCATION AND THE JOURNEY-TO-WORK: AN EMPIRICAL ANALYSIS†

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Abstract—In this paper we present and estimate a single equation model designed to explain the job-location behaviour of individuals living in a multi-centred metropolitan area. We test the model separately for heads of households and non-heads of households, as well as for the total working population, in order to isolate differences in commuting behaviour between primary and secondary wage earners. The relationships are estimated from 1971 Census, cross-section data using least squares multiple regression.

The results of the location equation indicate that wage gradient variables are important determinants of job location for heads of households. On the other hand, non-heads are rather insensitive to the wage gradient. Rather, contrary to the decisions of heads, the job-location choices of non-heads are strongly influenced by socio-economic attributes, notably occupation, family size and age. Clearly, job-location decisions of primary wage earners (usually the household heads) are influenced by earnings-maximizing considerations while secondary earners (non-heads in general) put more weight on other socio-economic factors. The results also suggest that there is a hidden cost associated with uneven directional growth in the Toronto CMA. It is suggestive that urban planning strategies should reflect consideration of the greater desire or need for accessibility on the part of secondary wage earners (non-heads) and the need to balance residential and job opportunities at the extending margin of the urban area.

1. INTRODUCTION

The subject of the journey-to-work has received considerable analytical attention. For the most part, this theoretical and empirical research attempts to explain the interrelationship between residential location and the journey-to-work[1-7]. These models assume a given job site and allow for the choice of a residential location in the urban area. It is no longer clear, however, whether households tend to locate their residences in response to a given job location or whether they tend to view their residence as given and look for a job in relation to it[8].

Accordingly, Beesley and Dalvi[8] construct two separate models to explain the length of the journey-to-work; one assuming a fixed workplace (residential location model), the other assuming a fixed residence (job-location model).† While the former follows in the tradition of most previous journey-to-work research, the latter represents a major departure from the past approaches and casts the problem in a significantly different light. It is this job-location model which provides the focus for this analysis and explores the relationship between the job location and the journey-to-work in the Toronto census metropolitan area (CMA).

In the job-location model, Beesley and Dalvi[8] assume that workers regard their residences as fixed and choose an appropriate job site in the metropolitan area. Given that there is disutility in commuting to the job site and utility from income earned, the focus in this model is on the increase in transportation costs vs the increase in potential earnings as the worker ranges farther afield from his/her residence site. Assuming a positive relationship between earnings and distance, Beesley and Dalvi[8], pp. 199-207, point out:

"Actually, it is rather far-fetched to consider the 'average' household as taking such simultaneous decisions... In reality, one cannot ignore the possibility that many journey-to-work decisions proceed from a fixed residence... and [that] it is not uncommon for people to start looking for jobs: from given home locations. This is particularly true for women and young entrants into the labor market, who may not be able or willing to leave their homes to take up better paid jobs outside their own urban conurbations... Thus some disaggregation of the decision process that determines journey-to-work length seems plausible..."

While both models are viewed as alternative explanations of the same phenomenon, i.e. the commuting behaviour of workers as reflected in journey-to-work distance, it should be stressed that these models are complementary and not competing accounts, since they imply quite different decision frameworks. We are thankful to Prof. M. E. Beesley of the London Graduate School of Business Studies and Peter Kettle of Nathaniel Lichfield and Partners, London, U.K., for suggesting this point in their comments and suggestions on our earlier paper. Gera and Kuhn[9].

†However, income is bounded from above, in the sense that there is an upper limit upon the amount of income one may earn by taking up jobs farther away from the residence site.
Dalvi indicate, for the individual’s utility to be at a maximum, the worker will locate his job at a distance from his residence site where the marginal increase in his income is equal to the marginal increase in his commuting costs.1 The model assumes, however, that there exists a “wage surface” in cities. Several authors, among them Evans[6], have suggested by deduction that there should exist, in cities, a “wage gradient”, or surface, analogous to the rent surface. Specifically, wages should be highest at the central business district (CBD) and should achieve lower peaks at secondary employment centres in order for equilibrium in the labour market to exist.

While Beesley and Dalvi’s model holds theoretical promise, due to severe data constraints there are a few problems that emerge from the empirical analysis. First, Beesley and Dalvi assume an increase in earnings is available to the worker if he works at a greater distance from home. Although this concept is theoretically analogous to the variation in location-rents around the workplace in the Residence Location Model, no attempts are made to account for variations in the “wage surface” as were made for the location-rent surface. Second, Beesley and Dalvi do not take into account job search costs which are related to the probability of finding a job in a given area. Finally, Beesley and Dalvi admit that the most important missing explanatory variable in their model is car ownership which plays an independent significant role in the journey-to-work models. Due to these limitations further empirical investigation in this direction seems appropriate.

The study is motivated by three main concerns. First, the area is underresearched, especially as far as empirical analysis is concerned, particularly in the Canadian context. Second, much of the theoretical and empirical analysis is primarily concerned with residential locational decisions and pays little attention to job location behaviour, when the polycentric nature of workplace locations is taken into account. Moreover, none of the researchers to date have analyzed this relationship by household status, i.e. heads and non-heads of households. Since non-heads of households (secondary wage earners) make up a very large and growing proportion of the commuting population in Toronto CMA, as in all Canadian urban areas, an understanding of the determinants of their journey-to-work behaviour is essential. Third, to improve the understanding of household’s behaviour with respect to the job location-commuting “decision complex” and the effect of this decision on urban structure.

Testing of the job-location model revealed that it is a powerful tool in explaining the variation in mean commuting distance, particularly of household heads, in the Toronto CMA. This suggests that job-location decisions of workers could be important determinants of journey-to-work distance.

The study begins with a recapitulation of the theoretical consideration underlying the structure of the job-location model followed by a description of the data used. Then, the model operationalization and specification are discussed and estimation results for the model are analyzed separately for heads and non-heads of the households. In conclusion the implications of the results both for the validity and usefulness of the underlying theory and for urban policy and planning are discussed.

2. THEORETICAL CONSIDERATIONS

The theoretical model of job location was developed by Beesley and Dalvi[8], who proposed that for some members of the urban population, particularly secondary wage earners in the family, variations in commuting distance may be best explained as rational economic decisions on where to work, given a predetermined residence site. The purpose of this model is to examine the job location behaviour of the working population within a multi-centre metropolitan area, when the polycentric nature of workplace locations are taken into account during the locational process. We now outline the assumptions and the structure employed for the proposed model.

Assumptions

(i) This is a consumer choice model, framed in terms of the working population. Each member of this population is assumed to maximize his or her net earnings (a necessary condition for utility maximization), this being defined as his other earnings (net of search costs) less the cost of commuting, by trading off travel costs to work against the potential increase in earnings by taking up employment at more distant location.

(ii) Given the polycentric nature of workplace locations, the worker’s residence is assumed to be given in any of the j residence zones and he or she is allowed to choose a job in any of the j employment zones. Every zone in the metropolitan area is considered both a residence and employment zone.

(iii) We assume that there is one, city-wide market for labour of all types, so that the average wage in a zone (when controlling for the effects of its occupational composition) is an indicator of the attractiveness of that area as a workplace to all workers.

(iv) There must be a known and sufficiently high level of moving costs involved in changing one’s place of residence to make the theory workable.

The structure of the model

Under our assumptions, we consider workers who are making a decision about job location in any one of the j zones in the metropolitan area, so as to maximize their net earnings. Following Beesley and Dalvi, let \( W \) be the worker’s earnings from employment in the home zone \( i \) (net of search costs), and \( W_j \) be the earnings from employment at a more distant location \( j \) (again, net of search costs). Assuming a positive relationship between earnings and distance,2 let

\[
W_L = W_i - W_i \geq 0
\]

where \( W_L \) is the potential earnings differential between employment sites \( i \) and \( j \). We assume that \( W_L \) is an

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1 Assuming that there is a limit to search for a better job, at some point there may be a disincentive to commute beyond a certain length; if the cost of moving is sufficiently low relative to commuting costs, the point will arrive at which the worker will move in order to have a shorter journey-to-work (in Beesley and Dalvi’s Evans, a “dominie shift effect” occurs [6], pp. 255–263).

2 However, earnings are bounded from above, in the sense that there is an upper limit upon the amount of earnings one may earn by taking up jobs further away from the residence site.
increasing function of journey-to-work distance \( D \) but that it increases at a diminishing rate with \( D \). Thus,

\[
WL = WL(D),
\]

(2)

Then, the individual's earnings (net of search costs) at any location \( j \) may be expressed as,

\[
W_j = W_i + WL(D)
\]

(3)

and \( W_i \) is defined as earnings (net of search costs) less commuting costs. Thus,

\[
W_i = W_j - T(D)
\]

(4)

where \( T(D) \) is the transportation costs, or

\[
W_e = W_i + WL(D) - T(D).
\]

(5)

Differentiating eqn (5) with respect to \( D \) and setting the derivative equal to zero, we obtain

\[
WL(D) - T_D(D) = 0
\]

or

\[
WL(D) = T_D(D)
\]

(6)

where subscripts represent partial derivatives. The above condition (6) indicates that for the individual's utility to be at a maximum, the worker will attempt to find a job at a distance from his (her) residence site where the marginal increase in his (her) earnings is equal to the marginal increase in his (her) commuting costs.

The standard implication for the job location behaviour of an individual, obtained from the above model, may be summarized as follows: An individual locates his job at a distance from the residence site so as to maximize his earnings, net of transportation and job search costs, by trading off possible increases in earnings at more distant job sites against marginal increases in commuting costs.

Conceptually, then, it appears that the optimum homework distance, \( D \), in this model is a function of two main factors—the rate of increase of earnings with distance from the residence site, \( WL(D) \), or the "wage gradient", and marginal transportation costs, \( T(D) \). If we further propose that a set of socio-economic and demographic factors \( SE \) may also have an effect on the optimum commuting distance, perhaps by affecting the utility of earnings, the structural form of the model can be described as,

\[
D = f(WL(D), T_D(D), SE).
\]

(7)

In Section 4, we consider the variables that fall under the three main categories—the "wage gradient", transportation costs, and various socio-economic and demographic factors—and we discuss their operationalization in this model.

3. THE DATA

From the responses to the 1971 Census of Population and Housing, it is possible to ascertain the residential location of the employed labour force of Canada, as of 1 June 1971. In addition, the 1971 Census collected job location information on a national basis for the first time. From these responses, journey-to-work data, consisting of the place of residence and place of employment, was coded for one-ninth of the complete population. Full population estimates were made by Statistics Canada from this sample. This study uses Statistics Canada's place-of-residence and place-of-work data for the Toronto Census Metropolitan Area (CMA). Although data for the Toronto CMA were available on a census tract (CT) level, the 453 CTs in the CMA were aggregated into 63 zones. For each of these zones in the Toronto CMA, information was available on the resident labour force \( L_i \) in the zone of residence; the working labour force \( E_i \), in the zone of work; and the flow of commuters \( a_{ij} \) between any pair of zones. Further, these data were disaggregated by socio-economic attributes such as occupation, sex, age and family size, etc. for this study.

The model is tested in terms of the "average" characteristics of the workers on a zonally aggregated basis. Ideally we would have liked to test the models in terms of the "individual" characteristics of the workers but could not do so due to data problems. All of the 63 zones in the Toronto CMA were assumed to be places of residence and places of work, so that two distinct data sets—one based on the average characteristics of the resident labour force \( L_i \) of each zone and the other based on the average characteristics of the working population \( E_i \) of each zone—could be constructed. In other words, the aggregate data are arranged separately for journeys originating or terminating in a given zone. It should be mentioned that the number of observations for each of the variables used in the model was equal to the number of zones in the CMA but that the average zonal value for each of the variables was calculated from individual observations ranging in number up to several thousands.

The job-location model, which assumes a fixed residence site, uses the first of the "data sets" described above, attempting to explain the variation in the average commuting distance \( D \) of all those resident in zone \( i \) (where \( i = 1, \ldots, 63 \)).

We test the model separately for heads of households and non-heads of households and for the total sample in order to isolate the differences in commuting behaviour between primary and secondary wage earners. An in-
spection of the data on the dependent variables in the models shows that the 545,520 household heads in the Toronto CMA travelled an average of 5.7 miles to work in 1971, while the 457,665 non-heads had an average distance of only 4.1 miles. Thus, important differences in commuting behavior seem to exist between the two groups; one of the main aims of testing the model here will be to highlight the reasons for these divergent observations.

4. ESTIMATION PROCEDURE

The factors that affect residence-work distance in this model fall under three main categories: the "wage surface", transportation costs, and other socio-economic and demographic variables. Based on eqn (7), the structural model can be specified as:

$$D_i = f(WGV_i, TC_i, SE_i)$$

where, subscript $i$ (i = 1, 2, . . . , 63) refers to the zone in which the residence is located, $k$ ($k = 1, 2$) represents household status, and $D_i$ = average distance of journey to work for workers by household status living in the residence zone $i$. $WGV_i$ = wage gradient at zone $i$. $TC_i$ = transport cost at zone $i$. $SE_i$ = socio-economic characteristics at zone $i$.

The model is tested in terms of the "average" zonal value for each of the variables. The variables included in the model are defined below.

In general, subscript $i$ refers to the zone in which residence located and $j$ to the zone in which the job is located, where $i, j = 1, 2, \ldots, 63$. Now, let $a_{ij} = $ number of workers commuting from residence zone $i$ to workplace $j$, $d_{ij} =$ air-mile distance between residence zone $i$ and workplace $j$, $L_i =$ total number of workers living in residence zone $i$, or

$$L_i = \sum_{j=1}^{63} a_{ij}.$$  

$WGV_i$ = wage gradient at zone $i$.

$TC_i$ = transport cost at zone $i$.

$SE_i$ = socio-economic characteristics at zone $i$.

$D_i$ = average distance of journey-to-work for workers living in the residence zone $i$.

$$D_i = \frac{\sum_{j=1}^{63} d_{ij}}{L_i}.$$  

$WGV_i$ = wage gradient at zone $i$.

$TC_i$ = transport cost at zone $i$.

$SE_i$ = socio-economic characteristics at zone $i$.

Independent variables

(a) Wage gradient variables. We assume that a wage surface, analogous to rent surface, exists in cities. This

$$W GV_i = \frac{W_i}{W_{CMA}}$$

where $W_i =$ average annual earnings of workers employed in zone $i$, $W_{CMA} =$ average annual earnings of all the workers employed in the CMA.

(b) Employment potential at residence zone $i$: This variable indicates the proximity of the worker's residence to high earning areas. On the basis of arguments similar to those given above in case of variable $WGV_i$, this variable $EP_i$, is expected to have a negative coefficient.

$$EP_i = \frac{E_i}{L_i}$$

where $E_i =$ total number of workers employed in zone $i$. When $i = j$, $d_{ij}$ was set at unity.
proxies: CO, and N,. Note that although the worker's
data on transportation costs, we use the following two
costs are very important in this model. In the absence of
well. Thus, the car might well be used for seeking a new
marginal cost of the journey-to-work. We propose here
search for a job as well. Thus, the car might well be used for seeking a new
job and be treated as an argument for search cost. It
should be mentioned that car-ownership is measured per
household rather than per worker in the 1971 data base.
The variable is calculated as follows: CO, = the percen-
tage of the workers living in zone i belonging to house-
holds which own one or more cars.

\[ CO_i = \frac{\sum CO_i}{L_i} \cdot 100 \]

where CO, = the number of workers in households
owning one or more cars and commuting from residence
zone i to workplace j.

\( N_i \) (workers belonging to families with more than
one wage earner): This variable, which indicates the
degree of family labour force participation, accounts for
the effect of joint commuting costs on journey-to-work
distance. It is expected that the presence of another
wage earner in the family by increasing joint commuting
costs, will induce workers to reduce their journey-to-
work distance. Thus a negative coefficient is expected.
The variable is formulated as follows: Ni = the percen-
tage of workers living in residence zone i who belong to
families with more than one wage earner.

\[ Ni = \frac{\sum N_i}{L_i} \cdot 100 \]

where Ni = the number of workers belonging to families
with more than one wage earner residing at i and work-
ning at j.

(c) Socio-economic variables. We recognize the effect of
a number of socio-economic and demographic factors
that may affect the distance workers are willing to
commute. Certainly, family size would be expected to
be important, especially for non-heads, as will occupation,
sex and age.

\( FS, \) (family size of the worker): In the job-location
model, the relevance of the family size variable is that
larger family size may have a positive effect on the
worker's utility of earnings, thus tending to increase
distance travelled as workers look farther afield to obtain
higher earnings. However, for non-heads of households,
the effect of this variable upon journey-to-work distance
is ambiguous because of two competing effects—the
"utility of earnings" effect and the "value of time"
effect. Since non-heads are more often associated with
child-rearing and home responsibilities than heads, we
might expect that non-heads would place a greater
emphasis on the value of time the larger the size of their
families. The greater the value placed on time, the
greater the transportation costs and the smaller the
commuting distance expected, in relative terms. This
variable is defined as follows: FS, = the percentage of
workers residing in zone i who are in (economic) families
of 3 or more persons,

\[ FS_i = \frac{\sum FS_i}{L_i} \cdot 100 \]

where FS, = the number in (economic) families of 3 or
more persons commuting from residence zone i to zone
j.

\( S, \) (sex of the worker): In several studies, it has
been found that male workers tend to travel longer
journey-to-work distances than their female counter-
parts. We would then, expect this variable to have a
positive coefficient. The variable is defined as follows:
Si = the percentage of workers living in residence zone i
who are male.

\[ Si = \frac{\sum Si}{L_i} \cdot 100 \]

where Si = the number of male workers commuting
from residence zone i to zone j.

\( AG_i \) (age of the worker): Given the well documen-
ted inverse association between age and other dimen-
sions of geographic mobility, we expect a negative
relationship between age and distance travelled to work.
The variable is formulated as follows: AG, = the average
age of workers living in residence zone i.

\[ AG_i = \frac{\sum AG_i}{L_i} \]

where AG, = the age of the workers commuting from
residence zone i to zone j.

\( O, \) (occupation of the worker): Although an income
variable could not justifiably be used in the job location
model (because, as noted above, income, in a theoretical
sense, is endogenous to the model), it was thought that
an approximation of the worker's income earning ability
such as occupation, could be useful. Theoretically, the
impact of this variable is multidimensional, so its expec-
ted sign is ambiguous. If blue-collar workers have a
lower income-earning ability, one would expect the lower
money value of travel time and higher marginal utility of
income for this group to encourage longer journeys-to-
work. On the other hand, analysis in another paper by
the authors indicated that, due to a tendency of blue-
collar residential areas and job sites to coincide in the
Toronto CMA, long-distance commuting was significantly less prevalent among blue-collar workers
than among white-collar workers. Thus we might expect

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this latter effect to dominate here as well, producing a negative coefficient for the occupation variable. This variable is defined as follows: \( O_i = \frac{\text{the percentage of workers residing in zone } i \text{ who are blue-collar (skilled and unskilled "manual" and "crafts and trades" occupations),}}{\sum_{j} O_j L_j \cdot 100}

where \( O_j \) = number of blue-collar workers commuting from residence zone \( i \) to zone \( j \).

5. EMPIRICAL RESULTS

In this section, we present estimation results of the testing of the job-location model, for household heads and non-heads together and separately. The equations are estimated with the least-squares multiple regression (OLS) technique. A measure of the accuracy of the model is obtained by the use of \( R^2 \) with \( F \)-ratio and the \( t \)-statistics of the regression coefficient in the estimating equation in conjunction with the average absolute percentage error (AAPE). For the AAPE is calculated as follows:

\[
\text{AAPE} = \frac{1}{n} \sum_{i} \frac{D' - D''}{D''}
\]

where \( D' \) = the estimated value of \( D \) (the journey-to-work distance), \( D'' \) = the actual value of \( D \), \( n \) = total number of zones used in the model.

The AAPE is a measure of the deviation of the estimated value of the dependent variable from its actual value, in percentage terms.

There is no theoretical justification for believing a priori that the relationship between our variables is linear. Moreover, an inspection of scatter diagrams between several independent variables and the dependent variable indicated the inappropriateness of attempting to fit a linear relationship to the data. Thus, the model was tested in semi-log form where except for the "wage gradient" variables and of socio-economic factors for non-heads. This becomes more apparent when we consider the effects of these variables below.

The first proxy for the wage gradient, \( W_G \), (relative annual earnings of those working in residence zone \( i \)), is found to be significant with the expected (negative) sign for the total sample (eqn 1) and heads of households (eqn 2), but is insignificant for non-heads (eqn 3). This result seems to indicate an important difference in the commuting behaviour of heads and non-heads of households.

We know that the mean commuting distance travelled by non-heads is significantly less than that travelled by heads;\( ^6 \) as well, our model indicates that the former's commuting distance is less sensitive to the level of earnings in the home zone. Thus the greater mean commuting distance of heads may be partially explained by the tendency for household heads to work farther from home if earnings near home are low and closer to home if they are high and the tendency for non-heads to work closer to the home zone regardless of the level of earnings.

The other wage gradient proxy, \( W_P \) (earnings potential at residence zone \( i \)), is insignificant in all the models; alternative forms of the variable are also found to be unsuccessful. This lack of significance may be due to the inadequacy of the variable as a proxy for the actual "earnings-distance opportunities" facing the worker, or may simply indicate that workers do not, in general, make the type of detailed earnings-distance comparisons implied by the theory—except, as we noted above, for assessing the relative earnings level in the home zone.

Employment potential (EP) is the most powerful variable (absolute \( t \)-value greater than 6.93 in all equations) in all three equations of the model. The EP variable indicates the probability of finding a job (presumably of a given type) in or near the home zone. In a sense, then, this variable captures the influence of "search costs" and job "choice" in this model. As expected, the elasticity coefficient for this variable indicates that the elasticity the availability of employment opportunities near the zone of residence, the shorter will be the average journey-to-work.

For household heads (eqn 2), none of the transport cost variables or other socio-economic characteristics are significant, implying that the high explanatory power of this model is due almost entirely to the influence of two features of the wage surface—relative earnings and the employment potential in the zone of residence. The simple fact that a worker is the primary wage earner for a family, then, seems to overshadow the effect of other socio-economic characteristics in determining the basis on which the job location decision is made.

The model results for the total sample (eqn 1) and for non-heads of households (eqn 3), are quite similar relative to the results for the heads of households (eqn 2). There are, however, some differences between the results for the total sample and for non-heads. For
Table 1. OLS estimation results: job location model explaining log(D) by household status, heads and non-heads

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Total (Both Heads and Non-Heads of Households)</th>
<th>Head of Household</th>
<th>Non-Heads of Household</th>
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<tbody>
<tr>
<td></td>
<td>Constant</td>
<td>Wage Gradient Variables</td>
<td>Transport Cost Variables</td>
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<tr>
<td></td>
<td>3.23</td>
<td>log WG1</td>
<td>COi</td>
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<td></td>
<td></td>
<td>log WF1</td>
<td>N1</td>
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<td>.059</td>
<td>.0031</td>
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<td>(1.07)</td>
<td>(0.96)</td>
<td>(0.59)</td>
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<td></td>
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<td>(-8.40)</td>
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</tbody>
</table>

| R2                                    | 0.90                                          | 0.91              | 0.85                   |
| F-Statistics                          | 60.50                                         | 56.15             | 37.86                  |
| AAPE (Average Absolute % Error)       | 7.28                                          | 6.44              | 7.48                   |
| Mean Value of Dependent Variable (miles)| 4.58                                          | 5.15              | 3.99                   |
| No. of Observations                   | 63                                            | 63                | 63                     |

*In a double-log form (or a semi-log form when the dependent variable is in logarithmic form) fit, the $R^2$ measures the proportion of the variation of the log D, that has been accounted for, which is not the same thing as the proportion of the variation of D. Thus to put the double-log equation on a comparable footing with one that simply has D as regressand, we took antilog of calculated values of log Dj and find their $R^2$ with the observed values of D. See Goldberger (20), p. 217.

Source: Statistics Canada and estimates by the authors.

example, although both variables relating directly to transportation costs (COi and Ni) are found to be insignificant in the total sample model, the car-ownership variable is significant and has a negative sign in the "non-heads" model (eqn 3). The unexpected sign of COi suggests that car-ownership would reduce the journey-to-work in this model. This counterintuitive performance of COi is probably related to the overriding impact of the urban structure factor EP (the zero order correlation coefficient between these two variables being -0.81). Thus car-ownership seems to be not so much an exogenous determinant of work-trip distance as it is simply another concomitant of the urban structural factors which do play such an important role in commuting.

The significant positive effect of the family size variable in the total sample (eqn 1) might be explained by the higher utility of earnings associated with greater family size tending to increase the distance travelled. In the non-heads equation, the coefficient of this variable is positive, larger than the coefficients for the other two equations and significant at the 99% level. We note that this result for non-heads is contrary to our expectations in the sense that the "value of time" effect was expected to weigh more heavily for non-heads than for heads relative to the "utility of earnings" effect, so that the coefficient for non-heads might have been expected to be less positive than that for heads, or even negative (our expectations were based on the idea that the greater child-rearing and other home responsibilities of non-heads in larger families might cause them to place a greater weight on the value of time than heads, thus in relative terms, increasing transportation costs and shortening commuting distance). This result could be due to those workers in the non-heads category who might exhibit a considerably greater utility of income because they are members of families where resources are thinly spread, or to the fact that the family size variable itself, which measures the prevalence of families with children in the zone, is actually reflecting the impact of many other causative factors—especially the predominance of a "suburban life style" with its concomitant higher commuting distances.
The sex (S) variable has the expected directional effect on the commuting distance but the coefficient is not significant in any of the equations of the model. Looking at the age (A) variable, we note that although it has a significant (at the 90% level) negative effect on the commuting distance for the total sample as expected, its significant positive effect for the non-heads is contrary to our expectations. It has to do with the labor market after child-bearing years, with workers having to leave their fixed location to find desired and appropriate jobs while younger non-heads may be less "choosy" and find jobs nearer to where they live.

Finally, occupation (O) has the most significant effect of all the socioeconomic factors on commuting distance for the total sample and non-heads (coefficient significant at the 90% level) showing the tendency of blue-collar workers’ residences and jobs to cluster in the same area of the city. This result is consistent with our findings in another paper which focussed specifically on occupation and commuting distance in the Toronto CMA.†

6. SUMMARY AND CONCLUSIONS

In summary, the empirical testing of the job location model for the Toronto CMA data provides a limited degree of support for the validity of the underlying theory of job location. The main findings of the model testing regarding the determinants of journey-to-work distance are summarized below:

(i) The effect of the wage gradient was operative only for household heads and seemed to be related to the pattern of urban growth. This is verified when we examine the urban patterns of earnings levels. Our examination yields two interesting conclusions. First, the high levels of earnings at or near the CBD (this is observed while comparing the average level of earnings paid in each zone in the Toronto CMA) confirm the theoretical expectations of Evans[6] who maintained that such a differential would arise to compensate workers at the CBD for their higher rents and/or commuting costs. Secondly, the general trend for earnings to be higher in high-growth western and north-western peripheral areas of the CMA tended to commute shorter distances to work than residents of low wage areas. This observation is supported by examining the pattern of employment potential by zones in the Toronto CMA. The strong tendency of employment potential to decrease with distance from the centre of the city in the Toronto CMA explains the tendency for commuting distance at the zone of residence to increase to high levels in the peripheral areas (usually low wage areas except to the west of the CBD). This was noted in the Toronto CMA (see Gera, Betcherman and Paproski [10], p. 133) and is supported when we examine the relationship between mean commuting distance at the place of residence (D) and residence zone distance from the CBD (DC).‡

(ii) Transportation costs did not seem to have an important effect on the commuting behaviour of household heads. Although the car-ownership variable is significant for non-heads, its influence is in a direction opposite to our expectations, this result likely being due to the overriding impact of the urban structure factor which we have labelled “employment potential”. The above two observations suggest that the worker’s job location decision is determined less and less by the transportation cost-potential earnings tradeoff and more by the distribution of employment opportunities and the factor of job choice.

(iii) It is the most important factor in determining home-work separation which captures the “search cost” aspect of job choice. The strong performance of the employment potential variable suggests that the collective employment opportunities are a major determinant of job location. The relative decline in the importance of urban transportation costs (due to mass car-ownership and other related factors) has made the worker’s search for a job of a given type (occupation, working conditions, etc.) a crucial determinant of his/her job location. Thus, the factor of availability and choice for the type of employment desired becomes important and this is reflected in the strong performance of the employment potential variable.

(iv) The residents of high-wage areas (particularly the high-growth western and north-western peripheral areas of the CMA) tend to commute shorter distances to work than residents of low wage areas. This observation is supported by examining the pattern of employment potential by zones in the Toronto CMA. The strong tendency of employment potential to decrease with distance from the centre of the city in the Toronto CMA explains the tendency for commuting distance at the zone of residence to increase to high levels in the peripheral areas (usually low wage areas except to the west of the CBD). This was noted in the Toronto CMA (see Gera, Betcherman and Paproski [10], p. 133) and is supported when we examine the relationship between mean commuting distance at the place of residence (D) and residence zone distance from the CBD (DC).‡

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The relative level of mean earnings in the home zone is taken into account by the workers than the zone’s general proximity to high earnings areas.

†See Gera and Kuhn[16].
‡The regression results of the relationship, $D = 2.89t(15.04) + 0.25 t(12.76), R^2 = 0.72$ (t-values in parentheses), support our contention.
§The job location model is highly relevant to heads of households, in particular those who have inhabited a given area for many years and face one or more new job location choices. This point was suggested by Prof. M. E. Beesley and Peter Kettle in their comments and suggestions on our earlier research—Gera and Kuhn[9].
money earnings among secondary wage earners, but more theoretical and empirical work in this area is required. Moreover, the greater socio-economic heterogeneity of the non-heads group suggests that one single model is not appropriate for all members of this group, which includes both working mothers and teenage workers, for example. The important steps that might be taken in this direction include: a more precise delineation of the secondary wage earner category and perhaps its subdivision into more homogeneous subgroups; consideration of the labour force participation decision simultaneously with the journey-to-work decision; and consideration of the influence of varying social norms on the labour force participation of the married women.

7. IMPLICATIONS

The findings of this paper suggest two important implications relevant to the future planning of metropolitan expansion and renewal in the Toronto CMA. These implications that emerge from the testing of the job location model in the Toronto CMA, although tentative, might be considered indicative.

(i) The observed responsiveness of the workers to the relative level of earnings received in the home zone and the zone's overall proximity to job opportunities may have some interesting planning implications for the Toronto CMA. The obvious implication seems to be that the growth of the residential population in areas of low relative wages and low employment potential will tend to increase the length of the work-trip. Considering these two aspects (relative wages and employment potential) separately, we can tentatively conclude that:

- the continuing movement of the residential population of the CMA into more and more peripheral and, hence, low-employment-potential areas, as the city grows seems to have an upward impact, as might be expected, on journey-to-work distance. This tendency of commuting distance to increase with residential decentralization may be seen as one of the costs of continued urban growth in large metropolitan areas;
- the negative relationship between earnings in the home zone and commuting distance has an interesting interpretation with respect to the direction of present and future growth in the Toronto CMA. While the results of our study directly suggest that the encouragement of more residential growth in low-wage (eastern) areas will tend to increase commuting distances, the encouragement of more employment growth in high-wage (western) areas may also tend to increase commuting distances, because of the "imbalance" in wage opportunities established across the CMA. Indeed, the tendency for residents of the slower-growing, lower-employment-potential, low-wage eastern parts of the CMA (much of Scarborough) to commute, on the average, longer distances to work than residents of the faster-growing, higher-employment-potential, high-wage western areas (Etobicoke, Mississauga), suggests that there is a hidden cost to the unevenness of the CMA in different directions. This cost is borne both by firms in high growth areas in terms of paying higher wages in order to attract workers, and by residents of the low-growth areas in terms of higher commuting distances or accepting lower wages itself as one of the long-run external benefits of cheap transportation, which led to the development of large, integrated urban areas offering a much greater variety of goods, services, residential environments and jobs. Thus, although our models say nothing about the optimality of the present situation, they do suggest that there is an important private and public tradeoff to be made between the amount of choice exercised and the amount of transportation undertaken. This relationship should be an important consideration in decisions affecting the cost and availability of urban transportation, its well-known external costs being weighed against its external benefits in terms of choice.

(ii) The fact that the commuting behaviour of secondary wage earners seems to be determined by a different set of factors from those influencing primary wage earners suggests that urban planning decisions should take into account the effect of this large and growing proportion of the labour force on travel demand. Although the relationships affecting the commuting distance of secondary earners do not fully and distinctly emerge from our model, further research is required, the apparently greater desire or need for accessibility by secondary wage earners should be an important consideration in future development decisions.

REFERENCES