Sex Differences in Urban Commuting Patterns

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This paper takes a new look, both theoretical and empirical, at the general question of what determines the pattern of urban workers' commuting journeys and at the specific question of how women workers' commuting journeys differ from those of men.

Commuting journey length for urban workers has proved difficult to model because it stands at the intersection of urban and labor economic theories concerning the spatial location patterns of jobs and housing. Urban economists view workers as having fixed job locations at the center of the city and being compensated for longer commuting journeys by lower housing prices in the suburbs. Labor economists, in contrast, tend to view workers as having fixed residential locations and being compensated for longer commuting journeys by higher wages at more distant jobs. See J. Madden and myself (1980) and Albert Rees and George Shultz (1970). The model presented here allows both locations to be determined simultaneously and both types of compensation for commuting to occur.

The problem gains an additional layer of complexity when sex differences in commuting patterns are considered, since sex differences in length of work trip are pronounced. Women workers have shorter commuting journeys, are more likely to take public transportation, and are more likely to work part time, therefore commuting at off-peak hours. Women workers also are more likely than men workers to have spouses who work and/or children at home; either of which may restrict their residential or job mobility. Also women workers earn less than men. This reduces their purchasing power in the housing market and therefore affects their job location and commuting possibilities. See Madden (1981).

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I. Theory of Residential and Job Location Choice

Consider first an individual household's residential location decision. Households determine their residential location by maximizing a utility function, defined over housing, a composite good, and leisure time. The urban economics literature has shown that if 1) all households have one worker whose job is at the city center, and 2) all households have identical tastes and the same wage rate, then a market equilibrium housing price gradient exists which makes all households indifferent concerning both the distance and the direction from the city center at which they locate. This housing price gradient is denoted $p(u)$, where u is residential distance from the city center and p is the per unit price of housing. $p(u)$ has its maximum value exactly at the city center, it declines at a decreasing absolute rate with distance from the center, and it is identical in all directions.

Extending the model, if households still have identical tastes and job locations but there are several wage-skill levels, then the housing price gradient which makes households indifferent over all locations differs by income level. This causes households having different wage rates to occupy different locations. Each wage class prefers to locate over a range of distances having the shape of a ring around the center, rather than everywhere in the city. In general, richer households have flatter price gradients and occupy more distant rings.

However, if an individual household's tastes differ from those of households generally, then the market equilibrium housing price gradient will not make it indifferent over all or a range of residential locations. Instead it will prefer one or two particular locations over all others. For example, sup-

pose a household has two workers rather than one, and both work at the city center. Then its commuting costs are higher than those of single-worker households having the same total income, so closer-in residential locations will be preferred. If it has two workers but one works in the suburbs, then it will prefer a residential location between the two jobs and probably nearer the suburban job, since housing prices are lower there.

Turn now to the pattern of workplace locations. Following the urban economics literature, I assume that there is some productive advantage to firms in being located at the city center. This could be because the center provides the broadest access to specialized services or skilled workers, or because it has the best transportation facilities. However, some employers have an incentive to move jobs to suburban locations. This is because in the suburbs they can pay lower wages to workers whose commuting trips are shortened. (Other prices also change for suburban firms, but we ignore them here.) The set of workers having the largest commuting cost reductions are those who live further from the center than the suburban job location and in the same direction away from the center. If the location chosen by the employer is v miles from the center, then each work day these workers save $2(m + w(v)/s)v$ in commuting costs; where m is monetary commuting expenses per mile each way, s is the speed of commuting per mile, assumed to be constant at all locations, $w(v)$ is the value of workers' time per hour, which will turn out to vary with job location, and v is the reduction in commuting distance each way that results from working at a suburban job.

Suppose some firms suburbanize, but they spread out in different directions and at different distances from the center. Each employs only workers who live further from the center than the firm and in the same direction away from the center. (Large firms are less likely to find suburban locations attractive than small firms, since by moving out they lose access to workers who live in other directions from the center.) Then there will be a market equilibrium spatial wage gradient, $w(v)$, determined by the process of location choice by employers and workers. The wage gradient has its maximum at the city center, declines with distance from the center and is uniform in all directions. It can be shown to decline at a decreasing rate with distance from the center. This is because from a fixed residential location, workers demand larger wage increments as they commute further inward towards the center. More time spent commuting reduces the total time available for leisure and work. Given diminishing marginal utility of leisure and goods consumption, greater loss of time must be compensated at higher and higher wage increments. (See my 1985 paper for a more detailed exposition of the model.)

Individual workers determine their job locations by maximizing their utility functions, taking as given the market wage gradient and the market housing price gradient (which has the same shape as in the centralized employment case). This means that, from a given residential location, they receive higher wages in return for commuting further, but only if they commute towards the center of the city. Out-commuting results in a lower wage per extra mile travelled, while circumferential commuting results in a constant wage regardless of miles travelled. If individual workers' tastes and other characteristics are the same as those of workers generally, then from fixed residential locations they will be indifferent among all jobs located between their residences and the city center. Extra commuting results in a higher wage just sufficient to offset the money cost and loss of leisure time of the extra distance travelled. From given job locations, workers face lower housing prices if they move their residences further out and commute greater distances, as long as they commute in an inward direction.

The model thus implies that workers whose households have typical tastes will be indifferent across all residential locations and across all job locations involving only in-commuting. Extending the model to include jobs involving multiple skill levels, each skill level will have a separate wage gradient. (However, firms hiring workers of different skill levels will be mixed at particular locations rather than segregated, as long as paying higher wages is not closely correlated with firms' willingness to pay for land.) Then

workers will be indifferent across all residential locations in the ring occupied by their income group and across all job locations involving only in-commuting from that ring. However, workers whose tastes are atypical will not be indifferent among residential and job locations. These workers will tend to prefer particular job or housing locations and particular commuting journey lengths. As an example, if the worker is a female head of household, then she may prefer a short commute because of heavy responsibilities at home. The market wage gradient may not be steep enough to induce her to commute more than the minimum distance.

The model's main conclusion concerning length of commuting trips is that the taste and demographic factors which differentiate individual households or workers from households or workers generally are the important explanatory variables determining commuting behavior. Only these prevent households and workers from being indifferent across a range of residential locations, across all job locations involving in-commuting, and therefore across a wide range of commuting journey lengths. To test this conclusion empirically, data are required for a sample of workers who are all located in the same metropolitan area, since the indifference property applies only across commuting journey lengths in a single city. I tested the model for several cities using data from the 1980 Annual Housing Survey. Due to space constraints, only the results for New York City are presented here.

The estimated equations explain length of commuting journey (in minutes), using income, taste, and demographic factors as explanatory variables. Because the model has no particular implications concerning functional form, the estimated equations are linear. The model is a reduced form. Neither the worker's wage nor the household's housing price is included as an explanatory variable. Since households maximize utility subject to exogenously determined market wage and housing price gradients, their actual wage and housing price variables each represent points chosen from the relevant schedules. These choices are therefore endogenous and including them in the equation would bias the results. As a result, the estimated coefficients in the commuting time regressions do not hold residential and job locations fixed. This means that if, for example, number of children increases, then the predicted change in the worker's commuting journey will incorporate the effect of changes in job or residential location that might be expected to occur as a result of the extra child, such as the worker's household moving to the suburbs.

In order to focus on sex differences in commuting behavior, separate equations are estimated for male and female workers. All workers in the data set are household heads, which biases the model against finding sex differences in commuting behavior since differences attributable to the behavior of secondary as opposed to primary workers are eliminated. The demographic variables are whether the household has a secondary worker or not (*P2WORKS*), whether there are preschool age children present or not (*YCHILD*), how many children under 18 are present (*NCHILD*), and a term interacting *P2WORKS* and *NCHILD* (*P2WCHILD*). Other variables are total family income (in thousands) in log form (*LINCOME*), whether the household head is black (*BLACK*) or is Spanish (*SPANISH*), whether the household owns its housing unit or rents (*OWNER*), and how many years since the household moved to its current housing unit (*YRSINHU*). No mode of travel variables are included, since choice of mode is also viewed as being endogenously determined by the same factors which explain commuting time.

The predicted effect on the household head's commuting journey of a secondary worker in the household could go in either direction, depending on where the second job is located. If both jobs are at the center, then the head's commuting journey is likely to be shorter. However if the head's job is at the center and the other job in the suburbs, then the effect of the second job may be to lengthen the head's journey if the household locates near the suburban job. A third possibility is that the second job has no effect on the head's commuting journey. More children

and especially young children are often thought to decrease women workers' commuting journeys, but this prediction is usually made for women who are secondary rather than primary workers. Higher income and owning housing are both expected to lengthen workers' commuting journeys, since both are associated with higher housing demand, which makes the suburbs' lower housing prices attractive. The variables for being black and Spanish are included since workers in each group are likely to locate in particular neighborhoods. But from these neighborhoods, most commuting may be outward or circumferential, making workers prefer to commute as little as possible. Of the other variables, longer residential tenure is likely to lengthen workers' commuting journeys if it implies less willingness to relocate when the worker changes jobs. It is included since New York has rent control, which holds down actual relative to market rent to a greater extent as households stay in the same apartment longer.

TABLE 1—COMMUTING JOURNEY LENGTHS FOR MALE AND FEMALE HOUSEHOLD HEADS, NEW YORK CITY, 1980[a]

	Females	Males
P2WORKS	.82	−.97
	(.24, .45)	(1.84) (1.05)
*NCHILD**	−1.00	2.73
	(.56, .90)	(.87) (.55)
*YCHILD**	8.53	−.56
	(.08, .20)	(2.47) (1.16)
P2WCHILD	−1.78	−1.79
	(.16, .39)	(1.55) (.75)
*LINCOME**	1.36	4.44
	(2.6, 3.2)	(.84) (.65)
*BLACK**	9.13	5.35
	(.27, .11)	(1.43) (1.26)
*SPANISH**	6.81	.76
	(.08, .07)	(2.26) (1.52)
*OWNER**	−1.69	5.34
	(.34, .66)	(1.52) (.96)
YRSINHU	−.31	−.30
	(6.4, 7.2)	(.18) (.12)
Intercept	26.94	20.37
	(2.55)	(2.15)
R^2	.03	.06
N	1448	5291
dep. mean	30.91	37.66
SSE	812,190	4,044,048

[a] Mean values of independent variables for females and males, respectively, are shown in parentheses below each variable.

II. Estimation Results

Regression results are given in Table 1, where standard errors are in parentheses. Asterisks give results of a separate statistical test for whether the male and female coefficients of each variable are significantly different. Despite the fact that both samples consist entirely of household heads, the results show substantial differences in commuting patterns by sex.

Turning to the household composition variables, children and secondary workers affect the commuting journeys of male and female household heads differently. Each extra child increases the commuting journey of male heads by 2.7 minutes if there is no secondary worker in the household, but by only .9(= 2.7 − 1.8) minute if there is a secondary worker. Thus male-headed households tend to suburbanize as they have more children, but the effect is much smaller if someone else in the household works. If the household has no children, then the second job has no significant effect on the head's commuting journey. However this result does not necessarily imply that working wives are forced to find a job from the fixed household residential location. Since the presence of a secondary worker can either raise or lower the commuting journey length of the household head, these two effects may offset each other in the data set.

In contrast, female heads' commuting journey length is not significantly affected either by the number of children, by the presence of a secondary worker, or by both at once. But the presence of young children has a large and significant effect which is positive rather than negative as expected—young children increase the commuting journey of female household heads by 8 minutes or 26 percent.

Other results are that male workers who own housing have longer commuting journeys than male renters, but the commuting journeys of female owners are not significantly different from those of female renters.

Also higher income by itself has only a small effect on commuting journey length for male workers and a small and insignificant effect for female workers. The small effect of income is not surprising since firms employing higher income workers also have a stronger incentive to move out as workers' wages rise. The length of tenure variable shows, contrary to expectations, that longer tenure in the same housing unit is associated with a shorter commuting journey, by .3 minutes per extra year of residence for both sexes. Rather than being forced to commute further because of their unwillingness to move when they shift jobs, workers having long residential tenure appear to adjust by finding jobs near their homes, perhaps at a sacrifice in income. For both sexes, being black is associated with a large increase in commuting journey length.

Thus male and female workers' commuting patterns are quite different generally and show different patterens of responsiveness to the presence of children and secondary workers, even when workers of both sexes are household heads. Male workers' commuting journey length is significantly shortened by the presence of a second worker, but only if there are children in the household. Female workers' commuting journeys are unresponsive to any of the demographic variables except for the presence of young children.

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