The Effects of Housing Prices, Wages, and Commuting Time on Joint Residential and Job Location Choices

Kim S. So, Peter F. Orazem, and Daniel M. Otto[a]

February 1998

[a]Iowa State University.

The Effects of Housing Prices, Wages, and Commuting Time on Joint Residential and Job Location Choices

Kim S. So, Peter F. Orazem, and Daniel M. Otto

Introduction

A major theme within the urban economics literature is the residential choice of households in which they trade off housing and commuting costs. The classic works of Muth, 1969 Mills, 1972 and Alonso, 1964 follow from this foundation and provide plausible implications for prices of housing and land, population densities, and household location in urban areas. A key assumption in these early models is that employment location is exogeneously fixed in the Central Business District with individuals free to choose their optimal residential locations anywhere in the metropolitan area (Mills, 1972). Empirical applications of the model have tested population densities, land rent gradients and wage rate gradients in relation to distance from the Central Business District (McMillien and Singell, 1992).

Employment growth in recent decades exhibits a more dispersed pattern than is assumed in the monocentric urban model, which has led some researchers to question whether housing and commuting costs are the appropriate basis on which to build a model of residential choice. For example, Hamilton (1982) concluded that the tradeoff between commuting and land rent might not play a significant role in residential decisions. Efforts to account for decentralization of employment have adapted the mono-centric model to include suburban nodes of employment that are also endogenously determined (Yinger, 1992 Wieand, 1987). Boarnet (1994) contends that whether employment is concentrated in the Central Business District is not the critical issue in this model. The important issue is the role that access to transportation plays in affecting urban population through employment and residential choices (Boarnet 1994). As a result, the basic residential choice model can still provide useful insights into housing and commuting cost issues.

Even as these models are extended to evaluate a wider set of issues, the majority of the monocentric and multi-centric models still rely on an assumption that residential location is endogenous to employment location, but that employment location is exogeneous to residential location. Efforts to deal with the joint determination of employment and residential location choices have tended to use aggregate data sets in their analysis (Carlino and Mills, 1987; Boarnet, 1994; Henry et al., 1997). To our knowledge, no studies have estimated the joint residential and job location decisions at the individual level.

This study uses the Public Use Microdata Sample (PUMS) of the 1990 Census to examine how wages, housing prices and commuting time affect the joint decisions of where to live and where to work. A multinomial logit framework is applied to a sample of 9,438 working-age (ages 22-62) residents of a 31 county region in central Iowa. Individuals choose whether to reside in a metropolitan or nonmetropolitan market, and also choose whether to work in the community in which they live or to commute to another town. In fact, all four possible residence/job location pairs occur in the data, although relatively few individuals reside in metropolitan communities and commute to nonmetropolitan jobs.

The model yields plausible estimates of the roles of economic variables on the joint residence/job location choices. In particular, the probability of residing in an area is negatively influenced by housing price levels, but positively influenced by wage levels. Incentives to commute are greater, the higher are wages in the other market. As a consequence, commuters have higher wages than do noncommuters, a requirement of the utility maximizing model. The probability of choosing the commuting option is negatively related to the commuting distance, with probability going to zero when the one-way commute approaches one hour. Consequently, the extent of the labor market around a metropolitan area is the distance that can be traveled in one hour.

Theory

Householders are assumed to jointly select a residential location and a work location so as to maximize utility. Indirect utility at residence i with job location j is given by

(1) $V_{ij} = V(W_j, C_{ij}, P_i, T_i), \quad i, j = M, N$

where M designates a metropolitan location and N designates a nonmetropolitan location, and where W_j is the wage the householder could earn in job location j, C_{ij} is the cost of commuting from residential location i to job j, P_i is the cost of living in residential location i and T_i is a vector of observed and unobserved locational preferences. Indirect utility is assumed to increase with the wage and decrease with commuting time and living expenses, so that $V_{W_j} > 0$, $V_{C_{ij}} < 0$ and $V_{P_i} < 0$.

The householder objective is the choose a residence and job so as to max (V_{MM}, V_{MN}, V_{NM}, V_{NN}). The optimality condition requires that the optimal residential and job locations i^* and j^* satisfy

(2) $V(W_{j^*}, C_{i^*j^*}, P_{i^*}, T_{i^*}) >= V(W_j, C_{ij} P_i, T_i) \_ i \_ i^*, j \_ j^*$

Equation (2) implies that commuters will require a wage premium over wages in their local market. An individual selecting a commuting job over a local job must have

(3) $V(W_j, C_{ij}, P_i, T_i) >= V(W_i, C_{ii}, P_i, T_i)$

where $C_{ii} < C_{ij}$. Because local tastes and prices are the same for the same residential location, W_j must be greater than W_i for (3) to hold. Therefore, we would expect average wages for commuters to exceed average wages for noncommuters, other things equal.

Equation (3) implies that as C_{ij} increases, $W_j - W_i$ must increase to compensate commuters. Therefore the gap between wages for commuters and noncommuters will rise as the distance between the metropolitan and nonmetropolitan areas increase. However, there is no requirement that average wages in the metropolitan and nonmetropolitan areas differ overall.

Average wages will differ across the two markets if $P_M \_ P_N$. By definition, nonmetropolitan areas have lower population density than urban areas. If higher population per square mile causes land prices to be bid upward, we would expect housing costs to be greater in metropolitan than in nonmetropolitan markets. Because housing costs are a significant share of consumer budgets, it is reasonable to assume that $P_N < P_M$. If for any householders,

(4) $$V(W_M, C, P_M, T_M) >= V(W_N, C, P_N, T_N),$$

then $W_M > W_N$ provided that $T_N >= T_M$ (average taste for nonmetropolitan residence is no lower than average taste for metropolitan residence).[1] Metropolitan wages will exceed nonmetropolitan wages even with $T_N < T_M$ if the disamenity of higher urban living costs exceeds the positive amenities of living in the metropolitan area.

Empirical Specification

The model requires data on home and job location choices, residential prices and wages for two contiguous locations, one metropolitan and the other nonmetropolitan. Householders are allowed four choices,

MM: live and work in the metropolitan area

MN: live in the metropolitan area and commute to the nonmetropolitan area

NM: live in the nonmetropolitan area and commute to the metropolitan area

NN: live and work in the nonmetropolitan area.

The general form of the indirect utility from each joint choice, V_{ij}, is given by equation (1). To operationalize (1), we assume the linear form

(5) $$V_{ij} = \alpha_W W_j + C_{ij} + \alpha_P P_i + T_i + e_{ij}; \quad i, j = M, N$$

The taste variables will only affect choices if they differ in impact across the two areas. Without loss of generality, we specify taste for nonmetropolitan residence to be $T_N = \beta_N$. Relative taste for metropolitan areas is assumed to be of the form

(6) $$T_M = \beta_M + \beta_{MA} A + \beta_{MK} K + \beta_{ME} E + \beta_{MY} Y$$

where A is respondent age, K is the number of children in the household, E is years of education of the householder, and Y is nonlabor income. The coefficients β_{MA}, β_{MK}, β_{ME}, and β_{MY} will be positive if the variable is associated with stronger preferences for urban residence. If age, having children, education or nonlabor income are associated with stronger tastes for nonmetropolitan living, then their respective coefficients will be negative.

The other specification choice is for the commuting costs, C_{ij}. These are assumed to depend on the length of commuting time, t_{ij}, but also on age, presence of children and nonlabor income. Commuting might be expected to be more difficult with age if younger workers have more energy. Children might make commuting more costly, if only because coordinating child care and job responsibilities is complicated when they are located 30 minutes apart.

Education would proxy for the value of time while commuting, but it should also be positively related to the ease of obtaining information on job openings across labor markets.

Increased nonlabor income may increase leisure demand and/or lower the marginal utility of income, lowering the incentives to accept higher pay in exchange for a longer commute. The assumed functional form is

(7) $$C_{ij} = a_C + g_t t_{ij} + g_A A + g_K K + g_E E + g_Y Y \,; \quad i \_ j$$

$$= g_t t_{ii} \qquad ; \quad i = j$$

The coefficients $?_A$, $?_K$, $?_E$ and $?_Y$ will be negative if the variable is associated with greater commuting costs across areas. If commuting time lowers utility, then $?_t < 0$. Inserting (6) and (7) into (5) yields the following system of equations:

(8) $$V_{MM} = b_M + a_W W_M + g_t t_{MM} + b_{MA} A + b_{MK} K + b_{ME} E + b_{MY} Y + a_P P_M + e_{MM}$$

$$V_{MN} = (b_M + a_C) + a_W W_N + g_t t_{MN} + (b_{MA} + g_A) A + (b_{MK} + g_K) K + (b_{ME} + g_E) E + (b_{MY} + g_Y)` + a_P P_M + e_{MN}$$

$$V_{NM} = (b_N + a_C) + a_W W_M + g_t t_{NM} + g_A A + g_K K + g_E E + g_Y Y + a_{PP_N} + e_{NM}$$

$$V_{NN} = b_N + a_W W_N + g_t t_{NN} + a_P P_N + e_{NN}.$$

If the error terms are independently drawn from an extreme value distribution, then multinomial logit estimation is appropriate for equation (8). The system of equations has 14 coefficients. This is a restricted form of the general multinomial logit specification which would have 24 coefficients.[2] The imposed restrictions include that the marginal utility of wage income a_W, is equal across choices, as is the marginal utility of commuting time $?_t$. Similarly, living costs have the same marginal utility across residential locations. These assumptions impose six restrictions. The remaining four restrictions come from imposing equal marginal effects of A, K, E and Y on utility of commuting, regardless of whether the commute is from M to N or N to M.[3]

Data

The empirical specification is applied to data from the 5 percent Public Use Microdata Samples (PUMS) of the 1990 United States Census. We concentrate on individuals aged 22-62 to avoid complications caused by social security and retirement. Individuals already retired by age 62 were excluded from the sample.

Households in the PUMS sample have completed the detailed Census survey providing information on individual and household characteristics including housing type, size and cost, utility costs, individual education, salary, occupation and time spent traveling to work. Households are assigned a PUMS region on the basis of location and the size of the region determined by population density. Thus the PUMS region in a rural area may include a dozen counties in order to achieve a sufficient population for the sampling frame, while a central city may be divided into several PUMS. Our study includes PUMS regions that form a rural to urban continuum of 31 counties from southern to north central Iowa. A total of 9,438 usable household records were included in the sample. The metropolitan residents in the sample are in the Des Moines SMSA, while the nonmetropolitan residents are in the PUMS regions surrounding Des Moines. Although the data include whether the place of residence and the place of work are designated as metropolitan or nonmetropolitan, the actual county of residence or work is not reported. This complicates obtaining measures of market prices for housing, wages, and commuting distance. Our strategies for developing these measures will be outlined in this section.

We require cross-sectional variation in wages and commuting times in order for identification. However, it would be incorrect to use observed wages or commuting time for individuals since these are chosen simultaneously with locational choice. Hourly earnings can be estimated from reported annual labor earnings, and data on typical hours worked per week and weeks worked per year. However, wage levels depend on labor supply choices. For example, Blank (1990) found that part-time workers earn less per hour than otherwise identical full-time workers. Averett and Hotchkiss (1995) found that benefits were also lower for part-time workers. In addition, self-employed individuals have complete control over their hours worked, making income and hours worked endogenous. These problems are further complicated by the need to derive a measure of expected wages in the labor market that was not selected.

Our strategy was to use average wages by education level and job location as the expected wage level in each market. To hold constant labor supply, averages were taken over full-time workers who are not self-employed. Consequently, averages were computed for each of six education levels: < 8 years, 9-11 years, 12 years, 13-15 years, 16 years, and 17+ years. For each householder, including those not employed or self-employed, expected wages were assigned using the average wage for the householder's education level. A similar strategy was used to assign expected commuting time for each of the four options. Thus, each individual has an expected wage and commuting time determined by the individual's education level for each potential choice. The wage and commuting values are reported in the Appendix.

Housing prices depend on both the quality of the housing stock and the price of land. The latter is the better measure of the relative cost of living, but absent information on location, land prices are not an option. The PUMS data offer a partial solution. While detailed information on housing quality is not available, the number of rooms is reported. Therefore, we report housing cost as the annual payment for housing divided by the number of rooms. For homeowners, the annual payment was assumed to be the per room implied payment on a 30-year loan with a fixed 8 percent interest rate plus the estimated real-estate tax. For renters, the annual cost of housing was twelve times the monthly rent, divided by the number of rooms. For the residential location not selected, housing costs were assigned based on the average price per room paid by residents of the same education level. Implicitly, this procedure assumes that relevant housing opportunities in the other location are defined by the type of housing consumed by householders of the same education level. The assigned housing costs are reported in the Appendix.

The remaining variables are self-explanatory. Age, education and number of children are taken directly off the PUMS tapes. Nonlabor income is the sum of reported savings, dividends, rent, government transfer payments, and other nonlabor income.

Empirical Results

The sample statistics are reported in Table 1 for samples which include and exclude household producers and the self-employed. The model was estimated over the complete sample including individuals out of the labor force and the self-employed to avoid a potential sample selection bias. If labor force participation or occupational choices are made jointly with locational choices, then exclusion of the self-employed or specialists in home production would amount to selecting on the dependent variable. As will be apparent later, the results of the model estimation are quite robust to inclusion or exclusion of the self-employed and householders who are not employed.

Several facts are worth emphasizing. First, average commuting time for those working outside their residential location is over two to three times the commuting time for those working in their residential location. Metropolitan residents have slightly longer commutes than nonmetropolitan residents. Commuters have higher wages than noncommuters, as required by the theory. Housing costs are lower in the nonmetropolitan areas. Wages are higher in metropolitan areas as required by the lower cost of housing in the nonmetropolitan areas. Metropolitan residents were more educated, had higher nonlabor income, and had smaller families than nonmetropolitan residents. Commuters were younger, more educated, and had lower nonlabor income than noncommuters. While these sample statistics are supportive of the underlying theoretical model, the stronger test comes from the estimation of the structural model.

The parameters of the multinomial logit model for both samples are reported in Table 2. In general, the model performed quite well. Most of the parameters are precisely estimated and correspond well to the theoretical model. Wages attract residents and commuters, while higher housing prices reduce incentives to reside in an area. As commuting time increases, incentives to commute decline. These results imply that longer commutes require higher wages to leave a worker better off than working in their place of residence. Areas with higher housing costs required higher wages to meet a worker's opportunity utility at other residential locations, or else wages must exceed those in other labor markets sufficiently to induce nonresidents to commute.

The remaining variables have interesting implications for residential preferences and tastes for commuting. The parameters b_{M_i} will be positive if the variable is associated with an increased interest in metropolitan residence. $?_i$ will be positive if variable i increases willingness to commute. The results suggest that older householders are less likely to commute and prefer to live in nonmetropolitan areas. Householders with children also prefer to live in nonmetropolitan areas. Interestingly, children do not appear to lower the probability of commuting. More educated householders are more likely to live in metropolitan areas, and are less likely to commute, although the effect is not precisely estimated. Householders with more unearned income prefer to live in nonmetropolitan areas, and are also less likely to commute. The latter effects are the only ones that differ, albeit modestly, when the samples include or exclude the self-employed and those not employed. In general, the parameter estimates appear to be robust to changes in sample definition.

Our primary interest is in the first three parameters. It is useful to convert these to elasticities to derive further implications of the empirical estimates. The comparative static elasticities are reported in Table 3. These elasticities measure the impact of a node-specific variable, X, on node choice under the assumption that X is unchanged at the other nodes. This is reasonable for commuting time since an individual could experience a change in job opportunities that change expected commuting time for a particular job location without altering commuting time to other job locations. Conceptually, one could also experience a wage offer at a specific location that leaves all other wage expectations unchanged. However, one could not have a change in housing costs that would not simultaneously alter expected residential prices for both working in the local market and commuting to other market while working in the local market. Therefore we concentrate on the comparative static elasticities for commuting time and wages.

The quantitative results are similar for the two samples, so we confine our discussion to the results for the sample which excludes the self-employed. Residential and job location choices respond inelastically to changes in wages. A ten percent increase in the expected metropolitan wage raises incentives to reside in the metropolitan area by 6 percent, but increases incentives to commute from a nonmetropolitan area by 7.6 percent. Increases in the expected nonmetropolitan wage raises incentives to live in the nonmetropolitan area by 3.7 percent, but raises incentives to commute from a metropolitan area to nonmetropolitan job by just under ten percent. It is reasonable that wages influence commuting decisions more than residential decisions because the fixed costs of commuting are lower than the fixed costs of changing residence. In other words, it will take a larger wage offer to induce an individual to move than that necessary to induce an individual to commute.

A percentage change in commuting time to a job alters the probability of commuting across markets more than it alters the probability of commuting within a market. Because average commuting time across markets is two to three times greater than average commuting time within a market, the differences in the elasticities is roughly comparable to the differences in mean commuting times across markets. The magnitude of the elasticities imply that incentives to commute across markets decrease rapidly as the commuting time between the metropolitan and nonmetropolitan markets increases. A ten percent increase in commuting time between metropolitan and nonmetropolitan areas reduces the proportion of commuters across the markets by 16 to 17.5 percent, evaluated at sample means. With mean commuting time of about 36 minutes one way, this implies that the probability of commuting from nonmetropolitan to metropolitan markets goes to zero at just under a one-hour commuting time.

The comparative static elasticities are appropriate for an individual householder, as it is possible, say, for a rural individual’s wage opportunities to rise in the metropolitan market without a coincident increase in average metropolitan wages overall. However, if wages for all commuters to metropolitan markets increase, then wages must be rising for residents of the metropolitan area as well. Table 4 reports elasticities which incorporate all possible cross effects of wages and housing prices. For example, the impact of metropolitan wages on incentives to live and work in the metropolitan area must also reflect the fact that incentives to live in the nonmetropolitan area and commute to the metropolitan area will increase as well. Therefore, the elasticity of MM with respect to W_M includes the direct effect (.60) plus the feedback effect from NM (-.11) for a total effect of .49. Similarly, the effect of W_M on incentives to live in the metropolitan area include the positive effect on MM and the negative effects on MN, weighted by their respective population shares. Similar methods are used to establish total elasticities for other wages and housing prices.

An increase in average metropolitan wages increases metropolitan resident employment by a greater proportion than it increases commuters into the metro. While some of the increase in MM comes from reduced commuting out of the metro, the MN source is numerically very small. The more important source is the reduction in NN, with some opting to commute to the metro and others moving to the metro to work. A ten percent increase in metropolitan wages will raise metro residents by 4.8 percent, reduce nonmetro residents by 31 percent and increase total commuters (increased NM net of decreased NM) by 3.5 percent.

Increases in nometro wages, W_N, have a larger proportional effect on commuters from the metro than on nonmetro resident employment. Consequently, nometropolitan populations grow more slowly in response to increases in W_N than did metro populations to W_M. Consequently, equiproportional increases in metropolitan and nonmetropolitan wages raise metropolitan populations and lower nonmetropolitan populations. As one would expect, if W_M and W_N increase by the same proportion, commuting across markets is unaffected.

Residential and job location are less affected by housing prices than by wages. A ten percent increase in metro housing costs reduces metro residence by .9% and increases nonmetro residence by .5%. Nonmetropolitan housing costs raise metro populations and lower nonmetro populations, but the elasticities are one-third smaller in magnitude. The effect of equiproportional increases in housing costs across all markets causes a very small relative shift of population toward nonmetropolitan areas. Comparing the third and sixth columns of Table 4, one can determine that equiproportional shocks to wages and prices (i.e. W_M, W_N, P_M and P_N all increase by the same proportion) will cause a slight shift of the population toward the metropolitan area.

The last exercise conducted in Table 4 was to measure the total effects of increased commuting time. The exercise assumes a one percent shock to commuting to and from the metropolitan market. When MM and NN increase by the same proportion, commuters decrease by roughly the same proportion in both markets. However, commuters are a much more important fraction of the nonmetropolitan population, so the negative effect on the nonmetropolitan commuter population is sufficiently large to cause a net reduction of the nonmetropolitan population. Over time, improvements in highways have reduced commuting times from rural to urban markets. Every ten percent reduction in commuting time raises nonmetropolitan population by .7% while it reduces the metropolitan population by 2.1 percent. The disproportionate share of the increase in the metropolitan population comes from an increase in commuters to metropolitan jobs.

The large negative effect of commuting time on probability of commuting implies a substantial associated disamenity. Therefore, a wage premium over the local wage is required to compensate commuters for the disamenity. A ten percent increase in commuting time lowers nonmetropolitan population by .7%.[4] The wage increase required in the metropolitan market over the local market is 5.2 percent if we use the comparative static wage elasticity or 9.6 percent if we use the total wage elasticity.[5] Therefore, the implied elasticity of W_M with respect to commuting time lies in the range (.5, 1.0).

As distance to the metropolitan area increases, the wage premium commuters will require increases. Given an invariant distribution of metropolitan wages, the costs of job search necessary to capture progressively higher commuting reservation wages are expected to increase, and so there will be an inverse relationship between number of commuters and distance from the metropolitan market, even as the wage premium paid to more distant commuters increases.

Conclusions and Extensions

This study shows that an empirical model of individual joint choices of residential and job locations can yield plausible results. Nonmetropolitan residents tradeoff lower housing costs for lower wages in the local labor market. Those that opt to commute to urban markets trade off higher wages for the disamenity of commuting time. All of these results are consistent with the underlying predictions of the theoretical model.

The results suggest that improvements in transportation that lower commuting time will increase nonmetropolitan populations and will increase the number of nonmetropolitan commuters to metropolitan markets. If instead, policies encouraged economic expansion in both markets which increased wages equally, population growth would be concentrated in metropolitan areas.

Consequently, improvements in transportation to metropolitan markets may be an effective means of extending economic gains to rural areas. It appears that non-metropolitan residents are willing to commute to the metropolitan markets if they live within one hour's distance or if transportation improvements bring them within one hour's distance.

The results herein demonstrate the interdependence of economic growth between urban and rural markets. Changes in wages and housing prices in one market affects the number of commuters and population growth in the other market. The interdependence between the markets suggests the economic development plans should be conducted on a regional basis rather than concentrating only on the metropolitan market or only on the nonmetropolitan market.

Table 1: Sample Means by Residential and Job Location

Sample including household producers and the self-employed.

(Residence, Job)	(MM)	(MN)	(NM)	(NN)	All metro residents	All nonmetro residents
Average commuting time (minutes)	15.297	36.640	35.678	12.292	15.922	15.706
Average housing price ($/room/100)	11.833	10.793	8.650	7.118	11.803	7.342
Average hourly wage ($/hour)	12.481	18.328	12.136	9.531	12.652	9.911
Age	38.9	37.1	38.7	40.7	38.8	40.4
Average no. of children	0.848	1.047	1.050	0.998	0.854	1.006
Average education level (years of schooling)	11.480	11.872	11.039	10.880	11.491	10.903
Average unearned income ($/1000)	1.317	1.008	0.759	1.258	1.308	1.185
No. of observations	2851	86	949	5552	2937	6501

Sample excluding the household producers and the self-employed.

(Residence, Job)	(MM)	(MN)	(NM)	(NN)	All metro residents	All nonmetro residents
Average commuting time (minutes)	17.151	36.479	35.500	15.268	17.743	19.085
Average housing price ($/room/100)	11.568	10.961	8.479	6.624	11.549	6.974
Average hourly wage ($/hour)	13.170	13.544	12.279	11.224	13.181	11.423
Age	38.1	37.1	38.3	39.2	38.1	39.0
Average no. of children	0.831	0.986	1.038	1.039	0.836	1.039
Average education level (years of schooling)	11.567	11.761	10.994	11.026	11.573	11.020
Average unearned income ($/1000)	0.938	0.765	0.693	0.731	0.933	0.724
No. of observations	2248	71	798	3432	2319	4230

Table 2: Coefficients from the Restricted Multinomial Logit Model of Residential and Job Location Choices

Coefficients	1[a]	2[b]
Location-specific		
a_W	.081*	.035*
	(3.90)	(2.17)
$?_t$	-.052*	-.078*
	(2.39)	(4.88)
a_P	-.012*	-.009*
	(2.22)	(2.30)
Individual		
$ß_{MA}$	-.013*	-.019*
	(4.88)	(8.37)
$?_A$	-.008*	-.014*
	(2.10)	(3.98)
$ß_{MK}$	-.185*	-.161*
	(7.46)	(7.58)
$?_K$	-.007	.125
	(.21)	(.43)
$ß_{ME}$	.068*	.092*
	(5.51)	(8.62)
$?_E$	-.008	-.007
	(.46)	(.50)
$ß_{MY}$	.030*	.008
	(2.89)	(1.31)
$?_Y$	-.002	-.045*
	(.10)	(3.18)
Constants		
$ß_M$	-.637*	-.753*
	(3.37)	(4.81)
$ß_M + a_C$	-2.79*	-1.99*
	(5.70)	(4.13)
$ß_N + a_C$	-.057	.804
	(.12)	(1.59)
N	6549	9438
Log likelihood	-6536.9	-8806.1

*significant at the .05 level.
[a]Sample of householders aged 16-61, excluding self-employed and those not employed.
[b]Sample of householders aged 11-61, including self-employed and those not employed.

Table 3: Elasticity Effects of Attributes on Choices

		Without Household Producers & Self-Employed	With Household Producers & Self-Employed
		Direct Elasticity Effects (Elasticity Effects on the other 3 Choices)	Direct Elasticity Effects (Elasticity Effects on the other 3 Choices)
Hourly Wage			
Choices:	M-M	0.60	0.28
		(-0.35)	(-0.14)
	M-N	0.96	0.41
		(-0.01)	(-0.004)
	N-M	0.76	0.34
		(-0.11)	(-0.04)
	N-N	0.37	0.14
		(-0.41)	(-0.20)
Commuting Time			
Choices:	M-M	-0.56	-0.74
		(0.31)	(0.35)
	M-N	-1.75	-2.63
		(0.02)	(0.03)
	N-M	-1.60	-2.47
		(0.23)	(0.29)
	N-N	-0.35	-0.331
		(0.40)	(0.49)
Housing Price			
Choices:	M-M	-0.09	-0.07
		(0.05)	(0.03)
	M-N	-0.14	-0.10
		(0.002)	(0.001)
	N-M	-0.08	-0.06
		(0.01)	(0.007)
	N-N	-0.04	-0.03
		(0.05)	(0.04)

Table 4: Total Responses of Residential and Job Location Choices to Wages and Housing Prices[a]

	Percentage Change in						
Node Choice	W_M	W_N	W_M, W_N	P_M	P_N	P_M, P_N	C_{ij}
MM	.49	-.42	.07	-.09	.06	-.03	.25
MN	-.46	.55	.09	-.09	.06	-.03	-1.52
NM	.41	-.42	-.01	.05	-.03	.02	-1.58
NN	-.46	.36	-.1	.05	-.03	.02	.25
Metro Residence	.48	-.40	.07	-.09	.06	-.03	.21
Nonmetro Residence	-.31	.22	-.08	.05	.03	.02	-.07
Commute	.35	-.36	.00	.04	-.03	.02	-1.58

[a]Based on the elasticities reported in Table 3 for the sample excluding the self-employed and those not employed.

REFERENCES

Alonso, W. "Location and Land Use: Toward a General Theory of Land Rent." Harvard Univ. Press, Cambridge, MA, 1964.

Averett, Susan L., and Julie L. Hotchkiss. "The Probability of Receiving Benefits at Different Hours of Work." *The American Economic Review* 85 (May, 1995):276-280.

Blank, Rebecca M. "Are Part-Time Jobs Bad Jobs," in Gary Burtless ed., *A Future of Lousy Jobs? The Changing Structure of U.S. Wages*. Washington D.C.: Brookings Institution, 1990.

Boarnet, M.G. "An Empirical Model of Intrametropolitan Population and Employment Growth." *Papers in Regional Science* 73 (1994):135-153.

Carlino, G. A., and E. S. Mills. "The Determinants of County Growth." *Journal of Regional Science* 27 (1987):39-54.

Hamilton, B. W. "Wasteful Commuting." *Journal of Political Economy* 90 (1982):1035-1053.

Henry, M. S., and D. L. Barkley. "The Hinterland's Stake in Metropolitan Growth: Evidence from Selected Southern Regions." *Journal of Regional Science* 37(3) (1997):479-501.

McMillen, D. P., and L. D. Singell, Jr. "Work Location, Residence Location, and the Intraurban Wage Gradient." *Journal of Urban Economics* 32 (1992):195-213.

Mills, E. S. *Studies in the Structure of the Urban Economy*. Baltimore, MD: Johns Hopkins Univ. Press, 1972.

Muth, R. *Cities and Housing*. Chicago, IL: University of Chicago Press, 1969.

White, M. J. "Location Choice and Commuting Behavior in Cities with Decentralized Employment." *Journal of Urban Economics* 24 (1998):129-152.

Wieand, K. F. "An Extension of the Monocentric Urban Spatial Equilibrium Model to a Multicenter Setting: The Case of the Two-center City." *Journal of Urban Economics* 21 (1987):259-271.

Yinger, J. "City and Suburb: Urban Models with More Than One Employment Center." *Journal of Urban Economics* 31 (1992):181-205.

Appendix: Values Used for Node-specific Wages, Commuting Time and Housing Costs, by Education Level[a]

Education Level		Node			
		MM	MN	NM	NN
< 8 yrs:	W[b]	8.14	10.14	9.08	8.77
	t	16.0	28.2	38.1	16.0
	P	920	920	556	556
9-11 years:	W	10.45	11.13	10.28	8.66
	t	16.9	35.9	35.2	14.8
	P	1078	1078	684	684
12 years:	W	12.07	10.59	10.45	8.71
	t	17.5	31.4	34.8	15.2
	P	1158	1158	694	694
13-15 years:	W	14.19	14.63	12.88	12.26
	t	16.2	35.3	34.7	12.7
	P	1324	1324	909	909
16 years:	W	23.59	22.60	13.78	14.46
	t	14.3	60.0	40.5	11.2
	P	1635	1635	998	998
17+ years:	W	16.11	16.61	13.26	19.37
	t	16.9	23.5	40.3	14.0
	P	1463	1463	1290	1290

[a]Averages based on samples of full-time workers aged 16-65 who are not self-employed.
[b]W is the hourly wage, t the commuting time (in minutes), and P the annual cost of housing per room.

ENDNOTES

1. Note that we fix commuting distance from M to N to be equal the commuting distance from N to M.

2. These would include a constant term and coefficients on W_i, t_{ij}, A, K, Y and P_i in each of the first three equations. Coefficients in the NN choice would be normalized to zero to insure that the probabilities across all 4 choices add up to one.

3. Tests of the restricted model against the unrestricted model will be distributed $X^2(10)$. The test statistic has a marginal significance level of around .005. Nevertheless, it is reasonable to impose the restrictions because of their consistence with theory.

4. At the sample populations of 8308, the number of commuters falls by 233, but 172 remain in the nonmetropolitan market in local jobs.

5. With 1473 commuters initially, and with a commuter elasticity with respect to W_M of .76, the implied wage increment to induce 58 more commuters is (58)/(.76)(1473) = .052 or 5.2%. If the NM elasticity with respect to W_M is .41, the compensating differential is (58)/(.41)(1473) = .096 or 9.6%.