Social Networks and ICT in Location Choice

Final Report

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CTS 09-19

Technical Report Documentation Page

1. Report No.	2.	3. Recipients Accession No.	
CTS 09-19			
4. Title and Subtitle Social Networks and ICT in Location Choice		5. Report Date August 2009 6.	
7. Author(s) Nebiyou Tilahun and David Levinson		8. Performing Organization Report No.	
9. Performing Organization Name and Address Department of Civil Engineering University of Minnesota 500 Pillsbury Dr. S.E. Minneapolis, Minnesota 55455		10. Project/Task/Work Unit No. CTS Project # 2008008 11. Contract (C) or Grant (G) No.	
12. Sponsoring Organization Name and Address Intelligent Transportation Systems Institute Center for Transportation Studies University of Minnesota 511 Washington Avenue SE, Suite 200 Minneapolis, Minnesota 55455		13. Type of Report and Period Covered Final Report 14. Sponsoring Agency Code	
15. Supplementary Notes http://www.its.umn.edu/Publications/ResearchReports/			
16. Abstract (Limit: 250 words) Humans are social animals. We routinely interact with others learning about one another, about places, where to go and what places to avoid. Our activities are coordinated with others; sometimes because we explicitly seek to physically meet with those we know personally, other times the coordination is systemic because of norms and requirements of when those activities can take place (e.g. shopping when the shops are open etc.). With those personally known, interactions serve to exchange information, form social bonds and to create social support systems. With in the transportation realm, the social dimension comes into play in different ways. Two or more people who want to meet face to face have to select a meeting location and travel to that destination. People can also learn about short-term activity locations, or about residences and workplaces through others and make location decisions based upon them. These two areas of social contacts' influence in the location choice is the topic of this report. The report looks into how job search methods can impact home and work location patterns at the aggregate level. It also investigates the role job search methods and their outcomes play in subsequent relocation and residential location decisions at the individual level. A third element that will be considered is the relationship between home, work and activity locations for social meetings. The roles of social networks are explored in work finding, residential location choice, and choices of meeting locations.			
17. Document Analysis/Descriptors Communication, information management, travel behavior, employment, activity choices, commuters, residential location		18. Availability Statement No restrictions. Document available from: National Technical Information Services, Springfield, Virginia 22161	
19. Security Class (this report) Unclassified	20. Security Class (this page) Unclassified	21. No. of Pages 92	22. Price

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Published by

Intelligent Transportation Systems Institute
Center for Transportation Studies
University of Minnesota
511 Washington Avenue SE, Suite 200
Minneapolis, Minnesota 55455

Acknowledgements

The authors wish to acknowledge those who made this research possible. The study was funded by the Intelligent Transportation Systems (ITS) Institute, a program of the University of Minnesotas Center for Transportation Studies (CTS). Financial support was provided by the United States Department of Transportations Research and Innovative Technologies Administration (RITA). The authors would like to thank Dr. Susan Handy for her helpful comments during the development of this study. The authors would also like to thank the State and Local Policy Program (SLPP) at the University of Minnesotas Hubert H. Humphrey Institute of Public Affairs.

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Executive Summary

Individuals routinely interact with one another learning about new things, about places, where to go, and what places to avoid. These interactions serve to exchange information, form social bonds and friendships as well as create social support systems. Within the transportation realm, social contacts can play various roles. Two or more people who want to meet face to face have to select a meeting location and travel to that destination. New destinations may also be learned of from such interactions. Even information on long-term locations such as residences and workplaces can be learned of through such contacts. These areas of the influence of social contacts in location choice are the topics of this report. The report also looks into how job search methods, including the use of contacts, can impact home and work location patterns at the aggregate level. It investigates the role job finding methods play in subsequent relocation and residential location decisions at the individual level. A third element that is considered is the relationship between home, work and activity locations for social meetings. The roles of social networks and ICT are explored in work finding, residential location choice, and choices of meeting locations.

This report is written as a set of largely independent chapters that are tied by the common theme of the role of social networks and ICT in location choice.

Chapter 2 discusses the possible roles that work and home-neighborhood social networks can play in finding residences and employment respectively. It posits that residential neighborhood level social networks and workplace social networks are important elements of work and home finding and lead to measurable levels of home-work co-location. Workplaces and neighborhoods are presented as centers of social network organization where information about neighborhoods or workplaces are exchanged. The outcome of such a process would be the existence of significant home-work co-location. The chapter empirically tests and finds evidence for such aggregation at home and work using areas of the Twin Cities employing the Longitudinal Employment-Household Dynamics (LEHD) and Census data.

Chapters 3 and 4 expand the job search process to include formal, internet, and newspaper searches in addition to contacts in job finding. This and the proceeding chapter employ data collected from Twin Cities residents using an internet based survey. The changes in technology that have happened in the past two decades and how job finding methods

have changed are explored. It also looks at who uses formal means, contacts, internet or newspaper for finding employment. The relationship between job-finding-path and work-location as well as relocation decisions are also investigated. Finally the impacts of changing work on commuting is explored.

Chapter 5 turns to social meetings. Social meetings are explored using one week data that is collected in from Twin Cities residents. Here the motivation is understanding the frequency as well as the where, when, and for what purpose of social meetings. The relationship between meeting duration, relationship quality, home to meeting-location distance, household constraints and neighborhood quality are considered with the aim of understanding the interactions among one another.

Chapter 1

Introduction

Humans are social animals. We routinely interact with others learning about one another, about places, where to go and what places to avoid. Our activities are coordinated with others; sometimes because we explicitly seek to physically meet with those we know personally, other times the coordination is systemic because of norms and requirements of when those activities can take place (e.g. shopping when the shops are open etc.). With those personally known, interactions serve to exchange information, form social bonds and to create social support systems. Within the transportation realm, the social dimension comes into play in different ways. Two or more people who want to meet face to face have to select a meeting location and travel to that destination. People can also learn about short-term activity locations, or about residences and workplaces through others and make location decisions based upon them. These two areas of influence of social contacts (information sharing that leads to location choice and direct arrangements) in location choice are the focus of this report.

The report looks into how job search methods can impact home and work location patterns at the aggregate level. It also investigates the role job search methods and outcomes play in subsequent relocation and residential location decisions at the individual level. A third element that we will look at is the relationship between home, work and activity spaces for social meetings. The roles of social networks are explored in work finding, residential location choice, and choices of meeting locations.

In work finding and residential location choice, the emphasis is on the role that contacts play in passing information about jobs, neighborhoods and housing. A long term location choice such as the selection of a work place requires searching for opportunities. By considering the search process, certain insights may be possible into where these activities take place and with whom they take place. For instance do neighborhood contacts help in job finding leading to co-location at home and work? In considering the search process, we also explore the technological changes in how information about jobs is found over the last decade and a half, and what implications it may have on employment location. We explore in what ways the commuting outcomes of opportunities that one finds by searching the internet vary from

opportunities that one finds through using newspapers or through contacts.

That social networks and their structure is key in a variety of individual and social activities from finding work to community organizing has been a topic of much research (e.g. (1; 2)). In different contexts, both close and distant contacts (strong and weak ties) are shown to be important in influencing getting a job (1; 3). In his study in Newton, MA Granovetter (1) found that most jobs at least in the professional management and technical fields were found via personal contacts (56.8%). Pointing to the inadequacy of models that assume rationality in the job search and overlook the importance of social networks, he explains jobfinding behavior is more than a rational economic process-it is heavily embedded in other social processes that closely constrain and determine its course and results.

Granovetter had also shown that weak social ties were especially important in job finding (4; 1). The rationale is that these individuals tend to move around in different circles from the job searcher and therefore are more likely to have information that the searcher doesnt. People that have strong ties to the searcher are more likely to know the same information as the searcher, and therefore are not very useful in relaying new and useful information. One of our interests in this study is to find out whether some of these contacts reside in the same neighborhood as the searcher. Wellman (5) points out that core relations around the individual are geographically dispersed, however, he also points out that a large number weaker ties are still present at the neighborhood level and at the workplace. The co-location at home and work maybe exploited to refine aggregate home-work matching models such as the gravity model.

There is also a growing area of job search that needs further exploration that has come about with the rise of internet use. Work by Kuhn and Skuterud (Kuhn and Skuterud 2000) finds that in 1998 15% of the unemployed as well as half of all jobseekers with internet access at home have used the internet to look for jobs. It is expected that a number of people find their jobs using this medium. The rise of internet use may complement as well as in some cases replace the job finding that is done through contacts. It may also be that there are differences across sectors of the economy on the prevalence of each method as a tool for finding jobs. It is expected that knowing the social and technological setting that leads to job finding, would allow more specific analysis of work destinations.

In this report we will explore co-location patterns at home and work and its implication for traditional travel demand models. We will also explore whether the search process has impacts on the distance travelled because of how and what information is gathered and presented to the searcher, and whether secondary/subsequent residential relocation is influenced by the process. For aggregate trip distribution models such as the gravity model co-location due to home/work place information exchange that leads to work/home selections would imply an OD matching that goes beyond origin, destination characteristics, impedance and population segmentation based on demographic characteristics alone.

For face-to-face meetings, the focus will be in the tradeoffs that have to be made to assure some level of travel cost sharing when face to face meetings occur. Social contacts and the

type of the relationship involved in a face-to-face meeting, it will be argued, play an important role in the selection of a meeting location and the allocation of time for the meeting. We will explore the role relationship strength and weakness have in how far one is willing to travel, and what amount of time they are wiling to spend at meetings. This fits into the time use and activity based research that has blossomed since the works of Hagerstrand (6).

Studies of time geography take time and space as inseparable in studying activities. Each activity has a location and an associated time which inturn place constraints for the activities that follow. It recognizes that humans live in a world of constraints which limit the reach of their movement and activity participation. Hagerstrand's (6) discusses these constraints, some of which are physical, as in rest requirements. Others have to do with authority over particular locations, and when one can and can not have access to particular locations. Yet another set is the requirements set by co-presence, such as shopper and shopkeeper, patient and doctor, etc. Their presence together are essential to the proper working of the transaction/activity in consideration. Such a conception also places additional constraints on other time uses by recognizing the limited time in a day that are available for allocation to other activities as would be true in reality.

One of the focuses of activity and time use research has been the investigation of the area that an individual participates in activitites. This area is given a great deal of structure by the home location because it is a daily destination and place of rest. Employed workers have a second location (their workplace) that they visit with regularity which gives additional structure to the location of other activities and limits the time they have for other activities. Changes in transportation technology and infrastructure have meant an expansion of this space over a long period of time. Hagerstarand (6) mentions the expansion of the "island" within which daily activities occur.

In time geography this space is characterized by the time space prism which forms the boundaries of the area within which activity engagement occurs. The area bounded by the prism constitutes all the potential locations for activity participation. Given the time constraints of departure and arrival at two activities, any intermediate activity can have its own potential area given the transportation technologies and the duration for the intermediate activity. For a fixed duration of activity and time availability between activities, car users would have larger potential activity areas relative to those walking for the intermediate activity. This area is the set of locations that can be reached while meeting the duration, departure and arrival time constraints. Within the prism a plot of locations and times of a particular individual represents the space time path. Miller (7) presents an overview of activities and time space concepts.

What interactions with others imposes is the reshaping of this area from what is feasible because of transportation capabilities to what is implied by the constraints that are placed by the location and time constraints of the person one is meeting. One's social contacts affect the decisions of where and when one engages in particular activities because of the contact's own constraints from other activities. Our choices of destinations for meeting friends depend

as much on whom we are meeting and their preferences as our own. In situations when other activities constrain the available time for a meeting for both individuals, the intersection of potential path areas for the meeting parties is where joint activities take place.

There is a growing recognition that social networks are an important part of the travel behavior exhibited by individuals. Investigating the role of social networks in social-activity travel, Carrasco et al. (8) find that there are systematic effects related to actors and their networks that affect the spatial distribution of social interaction. Proposals for incorporating the social network paradigm into activity-travel behavior has been made by Arentze and Timmermans (9). Hackney and Axhausen (10) propose an agent model of the interdependence of social networks and travel.

While the need for co-presence with other people is obvious in many activities,the expansion of communication technologies has opened up the potential to replace certain kinds of face-to-face meetings with email or phone conversations. Urry (11) points out that even in today's highly networked environment, co-present conversations are an essential part of social and economic life. He points out that such meetings enable the establishment of long term relations that require trust. One possible outcome is that advances in technology are very likely to replace the face-to-face interactions of contacts that are less important to individuals, instead choosing to communicate with them through less costly mediums such as email, or phone when instant responses are necessary. Urry (11) also points out that technology based meeting are good for task oriented relationships. This may also mean the availability of more time to interact with those close contacts of value to the individual. Coupled with the reduction in travel costs, another result of the expanding communication capabilities may have been the dispersion of close contacts over larger geographic areas and away from the neighborhood (5; 12). Axhausen (12) proposes that this spatial dispersion is a major source of observed increases in distance traveled especially for leisure activities.

From a planning perspective, studies on social networks and their influence on travel patterns are very recent. Though travel demand models have been around since the 1950s, the early models focused on aggregate formulations of the problem with little behavioral basis. Advances in disaggregate modeling have led to improvements in traditional models giving them a theoretical framework that related human behavior to transportation decisions. With time the models have progressed going from the traditional four step process to include disaggregate models of individual choice, and to activity-based models (13; 14). Further extensions of the disaggregate approach with joint destination-mode choice models have also been proposed (15). The trip based models are aggregate and had no room for characterizing personal relationships and their influences on travel.

The area of travel demand research that has found increasing attention in recent times is activity-based travel demand modeling which has its roots in the works of Hagerstrand (6) discussed earlier. Activity-based models are differentiated from the trip-based approach in that they explicitly consider the derived nature of travel demand. Further, these models allow trip chaining and coordination, which differs from the one origin-one destination formulation

of the four step process. These models take into consideration the temporal constraints that are placed on travelers' daily schedules. The strength of this approach is that it is based on the behavioral reality that people travel to engage in activities and it allows the actual behavior of trip chaining to take place.

The studies of social network influence that we cover in this report can have implications for both aggregate and disaggregate types of demand analysis approaches. In this report, separate chapters consider the role of neighborhood and workplace social networks in work finding and residence finding (chapter 2), the job search path and the relationship between job search path and commute as well as the connections with residential tenure and relocation (chapters 3 and 4). And the role of contacts in social meeting location choice and duration (chapter 5). The chapters are largely independent but are tied by the common theme of the role of social networks in location choice. Brief summaries of each chapter are given below.

Chapter 2 discusses the possible roles that work and home-neighborhood social networks can play in finding residences and employment respectively. It posits that residential neighborhood social networks and workplace social networks are important elements of work and home finding and lead to measurable levels of home-work co-location. Workplaces and neighborhoods are presented as centers of social network organization where information about neighborhoods or workplaces are exchanged. The outcome of such a process would be the existence of significant home-work co-location. The chapter will empirically test for such aggregation at home and work using areas of the Twin Cities employing the Longitudnal Employment-Household Dynamics (LEHD) and Census data.

Chapters 3 and 4 expand the job search process to include formal, internet, and newspaper searches in addition to contacts in job finding. This and the proceeding two chapters employ data collected from Twin Cities residents. In chapter 3 we look at which individuals are likely to use any one method to find work. The chapter explores the changes in technology that have happened in the past two decades and how job search has changed. In chapter 4 we explore the relationship between job search path and work location as well as relocation decisions. Here we explore what differences exist in the residential relocation decisions among people who used the different search methods to find their latest employment. Finally the impacts of changing work on commuting is explored. Through out the role of contacts, technology and formal means in finding work are explored.

Chapter 5 will turn to social meetings. Social meetings are explored using a one week data that is collected in from Twin Cities residents. Here the motivation is understanding the frequency and where, when, for what purpose of social meetings. Interactions between relationship quality, meeting duration, home to meeting location distance, household constraints and neighborhood quality are considered with the aim of understanding the interactions among one another. The contexts of relationships in influencing time allocation for meetings as well as in distance travelled are explored.

The proceeding chapters are independent but are tied by the common theme of the role of

social networks in location choice.

Chapter 2

Social Networks and Location Decisions

2.1 Introduction

Humans are social animals. We interact with one another, form different types of relationships, maintain ties with one another over time and space. We are continuously collecting information about each other, what we think of particular people, places, goods etc. A simple question such as "What did you do yesterday?" can garner a range of responses about neighborhood locations, schools, restaurants, and so on. To what extent these interactions inform our understanding of our environment depends on whom the information comes from, the type of relationship we have with them, how convincing they were, and whether the information gets reinforced through other channels. This process along with self experience helps individuals gather, discard, reinforce and refine their perceptions and knowledge about their environment.

On a day to day basis, much of the information gathering is passive. However, when the need arises for a particular good or information, the take-off point for the search is likely to be these stored information that have been built up over time. During an active search, the searcher can return to the original source for in depth answers or may seek alternate sources to refine the search. For example, a person who has mentioned his experience with a particular school district can be asked in depth questions, or one who seems to be well connected to employers of interest in past discussions can be asked to pass on a recommendation. Alternatively the searcher can seek out similar information from other sources in taking future steps.

The roles that social networks and their structure play in a variety of individual and social activities has been a matter of much research. These studies span multiple fields including labor market studies (e.g. (1; 16; 17; 18)), crime and unemployment (e.g. (19)), health (e.g. (20; 21)), child care (e.g. (22; 23)), inter-firm alliances (e.g. (24)) and others. More recently

the role of social networks in transportation decisions has also received increasing attention (12; 25; 10; 8; 9) among others.

In this study we explore whether interaction among social contacts is a significant source of information on jobs and housing. Specifically we are interested in the role neighborhood level and workplace level networks play in work and home finding. Our purpose in focusing on the neighborhood and workplace contacts is driven in part by the implications it has in transportation planning applications.

The neighborhood and workplace are seen as spaces that bring people together and facilitate information sharing. In this sense our conception is similar to that of Feld (26) who points out that many social networks develop around a *focus*. The "focus" in his theory can be anything around which joint activities take place including places, people, work etc. One of his basic propositions maintains that two individuals that are tied to the same focus are more likely to be tied to one another than two people not so related. Each individual can have many foci and different networks arising from their involvement in each, and can play different roles both within the focus and across foci. We will look at the workplace and the residential neighborhood as the foci around which social networks can develop and where information is passed among residents about work and among workers about residence locations.

One can see how sharing a home or work location can lead to higher chances of influence. Two persons, A and B, are more likely to know one another if they work at the same location than two individuals randomly selected in the population. If A and B know one another and have further similarities in other dimensions, then it becomes more likely that they would share their experiences and the possibility for mutual influence grows. On the home neighborhood side as well people who live close to one another have higher chances of knowing one another, and are more likely to interact with and influence one another as compared to two people randomly selected in the population. The possibility for acquaintance and influence increases further if they are involved in similar other activities (for example a home owners association, membership in a neighborhood club or if they have children going to the same school).

The link between where people live and go to work has been a topic of much research in transportation planning. Trip distribution models try to match origins and destinations, often using aggregate zonal variables to estimate the level of interaction between zones by the number of travelers going from an origin zone to a destination zone for different purposes. At its basic, the gravity model distributes trips from origins to destinations in direct proportion to the "size" (or some measure of opportunity) of the origin and destination and inverse proportion to the separation/cost between them. Explicit consideration of the job-finding or home-finding process within these aggregate models has not been made.

In the transportation context, the social network paradigm that is studied in this paper posits that home-work location sharing (co-location) would be higher than what can be explained by travel time, neighborhood characteristics and demographic preferences. If the influence of contacts is significantly observed, one would expect that certain residential neighborhoods

produce more workers for a given employment district than can be explained by travel time, and opportunities at the destination alone.

There are of course other mechanisms in which peoples' home and work locations can coincide. Some of the selection criteria that individuals use in selecting home or work locations would certainly include travel cost between home and work. Thus two people living in close proximity and having a short commute time, may work together without influencing one another. In addition home location decisions can be driven by people wanting to be close to those that are demographically more like them leading to the selection of some neighborhoods more than others. Observed levels of homogeneity in neighborhood racial composition, and economic class suggest that a household's decisions are impacted by others even when those "others" may not be personally known. Racial (27), income (28) as well as age (29) segregation are witnessed to different degrees. The analysis below seeks to investigate whether co-location among those that are spatially close to one another is significant even within such communities.

There is ample research in the field of sociology on the role played by social contacts in work finding. The economics literature on the other hand had widely adopted a search theoretic approach to the job search problem (see (30) for a review). Granovetter's (4; 1) work also identified which contacts were important in relaying information to find a job. He found that weak social ties, rather than strong ones with close family members and friends, were instrumental in relaying information that makes job finding possible. The rationale is that these individuals tend to move around in different circles from the job searcher and therefore are more likely to have information that the job seeker and their close contacts do not. People that have strong ties to the searcher are more likely to know the same information as the searcher, and therefore are not very useful in relaying new information (in contrast, in China, Bian (3) finds strong ties to be more effective in getting jobs where influence was essential). The existence of a consiedarable number of (weak) social ties at the neighborhood level is shown in (5). Here we ask whether these contacts are instrumental in work finding.

One of the biggest challenges in teasing out such relationship based outcomes at a large scale is the availability of data. In the next section we will discuss the data and methods we use to investigate the home and work relationships. That will be followed by an analysis of co-location patterns in eight areas in the Minneapolis-St. Paul metropolitan region. Finally, we investigate the relationship between comparatively high levels of colocation and different block level demographic variables and some conclusions are presented.

2.2 Data

The data for this study comes from the Longitudinal Employer-Household Dynamics (LEHD) program of the U.S. Census Bureau which compiles data from federal and state sources (31). Here we use the prototype OD matrix for 2002 for the state of Minnesota. The OD data

requires the linkage of residence and worker data that are gathered from the federal and state levels respectively. Description of the OD data is give in (32) and much of the description of the data below borrows from this description.

Residence location data for the LEHD is gathered from the Census Bureau's Statistical Administrative Records System (STARS) database. Stars includes data compiled from records including federal tax forms, medicare, HUD public assistance, selective service registration and so on. The data is geocoded and locations for about 10% of the workers that are not geocoded are imputed.

Data on the work locations comes from States. In this case the ES-202 report from State of Minnesota's Covered Employment and Wages program is used. The data is reported by employers whose employment is covered under Unemployment Insurance. The Minnesota data is estimated to cover 97% of non-farm employment in Minnesota (33).

The worker-employer link in the LEHD data is derived from Unemployment Insurance wage reports supplied by the State of Minnesota. Part of the strength of the Minnesota data is that work locations are reported at the establishment level within an employer allowing more accurate O-D matching. Some states reports may show the head office but not identify the establishment at which a particular worker is employed requiring additional models to assign work locations.

For confidentiality, the LEHD reported OD trips only if the origin had at least five workers living in it, and if the trip makers had three or more destination blocks. Later versions of the LEHD have used other methods to preserve confidentiality.

We have limited our analysis to origins and destinations within the seven-county metropolitan area of the Twin Cities (Minneapolis-St. Paul)[1]. In the following sections we will investigate the extent of co-location at home and work between residents of several blocks and study how the degree of co-location varies across the demographic make up of the census blocks [2].

For the first part of the analysis eight areas, each constituting several census blocks are selected. Four of these were selected in the city of Edina and four in the city of Brooklyn Park. The number of census blocks in the selected areas ranged between 11 to 23. Each group is selected to have approximately 500 workers. The second part of the analysis will look at how co-location at work is distributed across the metropolitan area. The extent of co-location is analyzed against the demographic makeup of the census blocks utilizing demographic data from the U.S. decennial census. The analysis will include all metro area census blocks where the origin had at least two workers originating from it to any metro area work block.

[1] The seven counties are Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington counties.

[2] A census block is the smallest geographic area for which the Census Bureau presents data. Blocks are grouped together to form block groups.

2.3 Methodology

We are interested in testing (i) whether work census-block sharing among people who share a home census-block is higher than what we would expected by travel and land use considerations and (ii) which census-blocks exhibit relatively higher home-work sharing. The first of these questions would indicate the presence of a coordination mechanisms among people in their choice of home and work locations. This would support the neighborhood & work place information flow hypothesis we have presented above. The second part of the analysis would explain what type of neighborhoods exhibit it strongly relative to others.

The first part of the analysis will borrow methods from Social Network Analysis. We measure the extent of home-work co-location by building adjacency matrices for residents of the areas under consideration at home and at work. A network adjacency matrix is a matrix representation of the relations between the members of a network. Because of the level of detail in the LEHD data set, we define a relationship as sharing a census block for residence or sharing census block as a work destination. The home and work relationships are depicted in two adjacency matrices, one for the residence end (H) and one for the work place (W). For a selected area that has N workers as residents, the adjacency matrices for the H and W matrices will be NXN in dimension, where each row and column represents one individual. Cell $[i, j]$ of the H matrix will have a value 1 if person i and person j share a home location or 0 otherwise. The same element in the W matrix will have a value of 1 if i and j work together and 0 otherwise. Both H and W are symmetric matrices. The diagonal elements are ignored as they do not have any meaning. For an area that has N residents there are $N(N-1)/2$ possible relationships.

Having defined the home and work matrices, our study focuses on the relationship between these matrices. Specifically we ask what the degree of association between these two matrices is when both matrices are defined over the same subset of individuals. We are also interested in running statistical tests on the level of association between the matrices. We employ three measures to measure the level of association between the home and work matrices. The measures of association are Pearson correlation, simple matching and Jaccard coefficient. Simple matching and the jaccard coefficients are calculated as follows:

Simple Matching: The simple matching coefficient measures to what extent the two matrices at the home and work block level are similar entry by entry. There are $n(n-1)/2$ relationships defined in each matrix. This measure tells us what proportion of these relationships are equal to one another in the home and work adjacency matrices. For instance a 0.6 value means 60 percent of the relationships defined at home and work are the same (60% of relationships are absent or present at both). The measure is calculated as follows:

$$M = \frac{C}{C + D} \tag{2.1}$$

where C is the count of matched pairs (0-0 or 1-1) and D is the count of un-matched pairs

(0-1 or 1-0) between the H and W matrices.

Jaccard Coefficient: The Jaccard coefficient looks at what proportion of possible ties are matched between the home and work location relationships. This measure excludes all values that are matched 0s in the home and work adjacency matrices.

$$J = \frac{C_{11}}{C_{11} + D} \tag{2.2}$$

where C_{11} is the count of matched 1-1 pairs and D is the count of unmatched pairs (0-1 or 1-0) between the H and W matrices.

One of the challenges in applying statistical tests to relationship/network data is that observations are not independent of one another. Each entry of the matrix reports the presence/absence of a relationship between two actors, thus observations on relationships involving the same actor are not independent of one another. This makes hypotheses tests that assume independence between observations less useful. Social scientists have been dealing with such data in other contexts. One solution that has been used to address this problem is using Quadratic Assignment Procedure (QAP)(34).

QAP is a non parametric test that depends on repeated permutation of one of the network matrices and building a distribution of the test statistic of association under the null hypotheses. The permutation preserves the structure of the network while it relabels the vertices of the network. In our case for instance, if we were permuting the work matrix W, we would be exchanging relationships among the individuals in consideration, while maintaining the size of the clusters. From a trip distribution stand point, one can think of this as reassigning the destination blocks of the agents in the network while maintaining employment levels at each of the destination blocks. Figure 2.1 illustrates what the process does in the context of our analysis. The relationships at the home location remain unchanged through out the procedure. Under successive permutations, the number of people employed at each of the destination blocks under consideration also remains unchanged. The difference is that at each iteration the employees that fill the positions are now pulled from different origin blocks. For example in Figure 2.1 the destinations have 3, 3, ,3 and 1 employees respectively under the observed network as well as under permutations. However, different individuals are fill these positions under the permutations.

It is important to note that the QAP test, as well as the H and W matrices, do not explicitly control for origins and destinations. The method is generic enough to be applied to any type of network. The only information contained in the matrices is which groups of individuals are related and the structure of the network that develops (e.g. how many ties are there? how many cliques etc.). Under permutation, the structure of the network is unaffected. For instance the total number of ties, the number cliques as well as the size of each clique is not affected. The QAP test simply exchanges the relationships in the W matrix and calculates the test statistic of interest against the H matrix. After several iterations, the distribution of the test statistic under permutation is compared to the original test statistic.

The percentage of statistic under permutation that are as great or greater than the original test statistic serves as the p-value of the test.

To answer whether work census block sharing is higher among people who share a home census-block, we start by selecting several areas and build the H and W relationship matrices for workers in living in the selected area. Our selection strategy is for each area to include a number of census blocks that are adjacent to one another and to analyze each group separately. As will be illustrated in the next section, there are certain advantages of selecting census blocks that are close to one another. First blocks that are close to one another tend to be more socio-demographically homogenous than a randomly selected set of blocks. Our intention is to illustrate that even among a demographically homogenous group, people who are closer to one another tend to work together than those slightly farther from them. Second distances to different land uses around them are relatively similar. Third, by selecting home blocks that are adjacent to one another we are more or less maintaining the overall origin-destination distance distribution. If one were to map the destination locations under permutation, the home to work distance of any one individual can change significantly from the original depending on whose position they are now assigned in the network. However, because the selected residential locations are very close to one another and the distance between homes is small, the overall distribution of distance is not affected significantly.

In permuting the adjacency matrix we start by generating a permutation vector. A simple way to think about this vector, and one which works with our context of reassigning destinations, is that its k^{th} element of the vector designates which position individual k in the original matrix would take. Consider the simple adjacency matrix shown below which shows the work-colocation between five individuals along with the permutation vector and the adjacency matrix permuted format. Under permutation, the first person is now assigned the position previously held by person 2 and will have two ties. Because the other persons are also reassigned, the relationship is not necessarily with those person 2 had relationships with. If the home locations of persons 1-5 is the same, and they are now simply reassigned to the work locations of the element in the permutation vector, the overall distribution of distances will remain the same.

$$\begin{bmatrix} - & 0 & 0 & 1 & 0 \\ 0 & - & 1 & 0 & 1 \\ 0 & 1 & - & 0 & 0 \\ 1 & 0 & 0 & - & 0 \\ 0 & 1 & 0 & 0 & - \end{bmatrix} \qquad \begin{pmatrix} 2 & 1 & 5 & 3 & 4 \end{pmatrix} \qquad \begin{bmatrix} - & 0 & 1 & 1 & 0 \\ 0 & - & 0 & 0 & 1 \\ 1 & 0 & - & 0 & 0 \\ 1 & 0 & 0 & - & 0 \\ 0 & 1 & 0 & 0 & - \end{bmatrix}$$

This point can be illustrated using one of the areas selected for the analysis in the next section. The area Brooklyn Park 2 in table 2.1 includes 495 workers originating from 19 census blocks and destined to 263 census blocks. The resident's home coordinate is designated by the coordinates of the centroid of their home census block and their work coordinates are also designated by the centroid of the destination. Calculating the new home to work

distance under 1000 different permutations and comparing the distance distribution to the actual distance distribution using a two sided t-test, no evidence of difference between the distributions was detected with p-values ranging from 0.865 to 0.970.

Thus under the quadratic assignment procedure and the sampling strategy we have adopted (i) home locations remain unchanged (ii) employment levels at destinations remain unchanged and (iii) the overall distance distribution also remains relatively the same.

2.4 Analysis

2.4.1 Measuring Association Between Home and Work Co-location

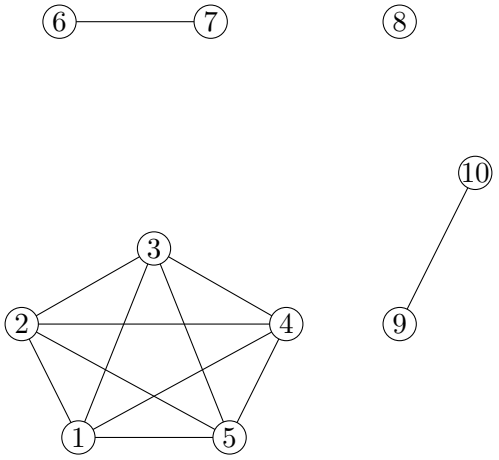
The QAP analysis described above is applied to eight areas in the cities of Edina and Brooklyn Park, Minnesota, part of the Twin Cities Metropolitan region. Four areas are randomly selected with in each city. Each of the selected areas had several blocks within it and approximately 500 workers destined to different blocks in the metropolitan area. Detailed results for one group of blocks in Edina will be presented and we will summarize the results for the remaining groups of census blocks in table 2.1.

The first group of blocks in Edina (Edina 1) contains fifteen census blocks from which 495 workers originate. The workers are destined to 235 census blocks for work. Under permutation, people are assigned new co-location relationships at the work location. The area is also demographically relatively homogeneous as compared to the city of Edina. Figure2.2 shows the distribution of racial makeup, average family size, and median age in the census blocks of the city of Edina and the first group of blocks.

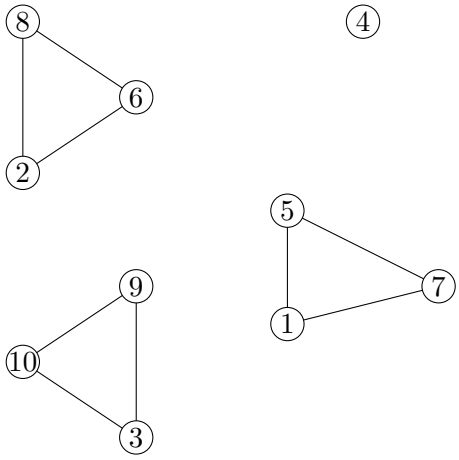
Table 2.1 shows the results of the QAP analysis using all three measures discussed above. In each case, while the magnitude of the measures are low, they exist to a degree that cannot be easily replicated by exchanging the work locations of the individuals. The last column in the table in the column serves as the measure of p-value of the test. In 1000 permutations, no measure of simple matching, jaccard coefficient or correlation as large as that in the observed network was observed.

The results for the three other groups of blocks in Edina and the four groups of blocks in Brooklyn Park are also similar (see Table 2.1). The association measures under permutation are less than what is observed in the observed arrangement.

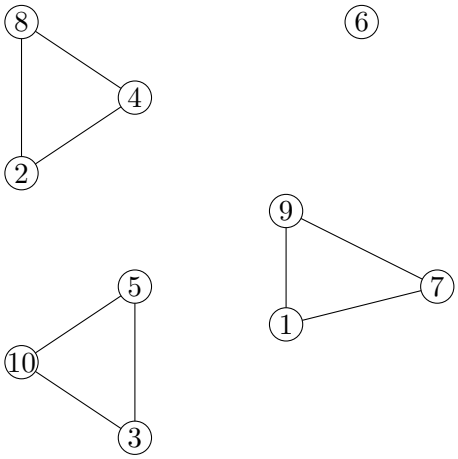
By selecting census blocks that are close to one another we have attempted to control for distance impacts as illustrated earlier. The permutation process itself ensures that the total number of persons working together is kept the same by retaining the structure of the network. Only the identities (and hence where they are attracted from) of the individuals that are working together is changed. The results suggest is that there are possible mechanisms that lead to co-location patterns that are significantly different from what are possible



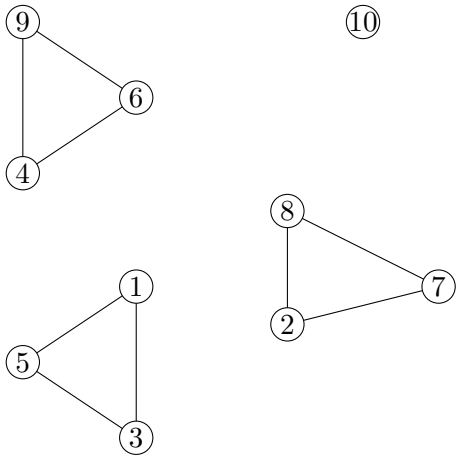
(a)Home relationships



(b)Work relationships



(c)Permuted work relationships 1



(d)Permuted work relationships 2

Figure 2.1: Sample home and work networks

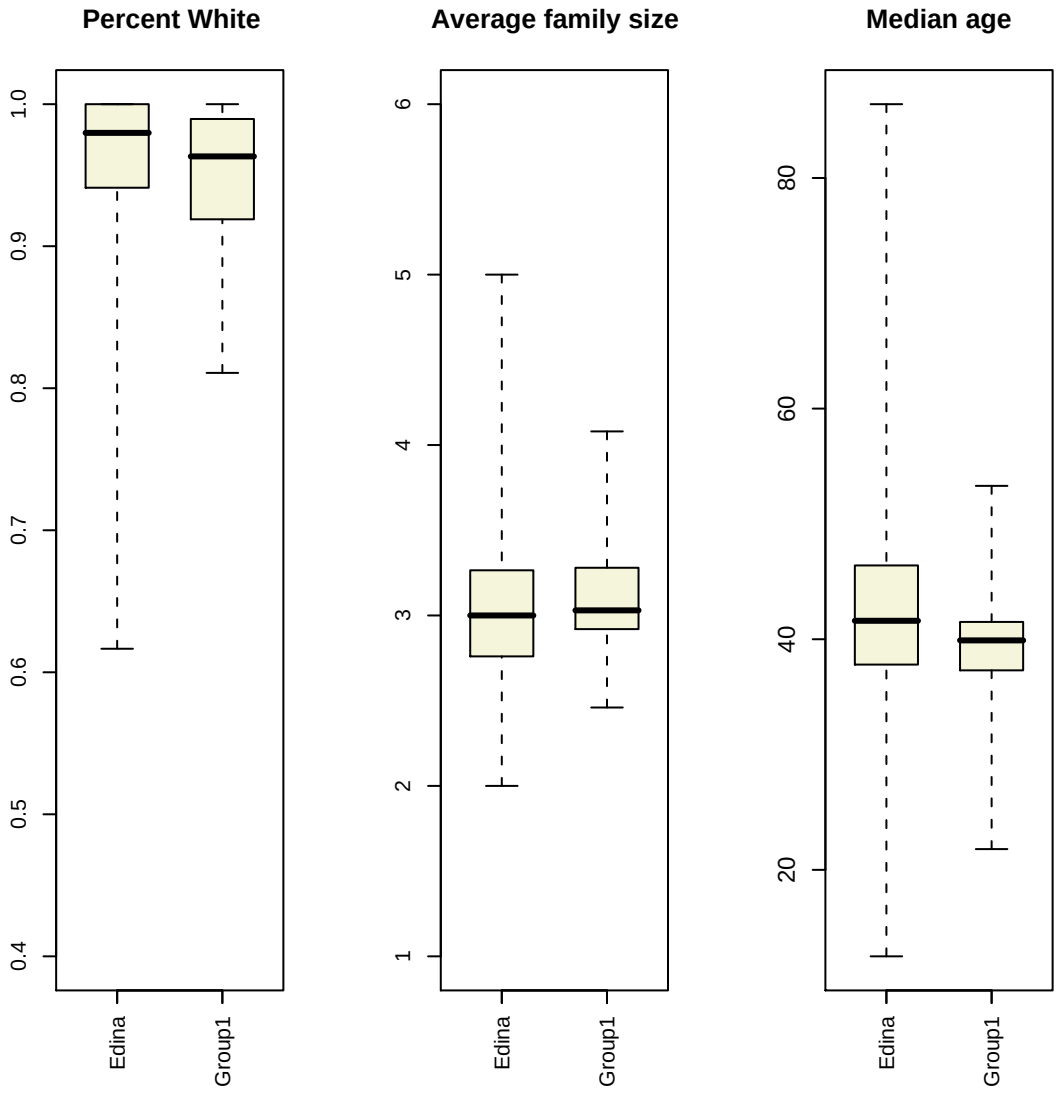


Figure 2.2: Boxplots of the distribution of demographic variables in selected Edina blocks. The box shows the interquartile range, while the whiskers extend to the range of the the observed values. The median is shown by the bold line within the box.

arrangements of employment.

Table 2.1: Quadratic assignment procedure results

Group	Number of origin blocks	Number of destination	Number of workers	Association measure	Observed	% greater (p-value)
Edina 1	15	235	495	J	0.03	0.00
				S	0.91	0.00
				C	0.08	0.00
Edina 2	21	256	504	J	0.03	0.00
				S	0.93	0.00
				C	0.09	0.00
Edina 3	11	223	481	J	0.03	0.00
				S	0.93	0.00
				C	0.05	0.00
Edina 4	23	241	511	J	0.03	0.00
				S	0.93	0.00
				C	0.10	0.00
Brooklyn Park 1	19	263	495	J	0.03	0.00
				S	0.92	0.00
				C	0.10	0.00
Brooklyn Park 2	22	263	494	J	0.03	0.00
				S	0.93	0.00
				C	0.12	0.00
Brooklyn Park 3	13	307	606	J	0.01	0.00
				S	0.58	0.00
				C	0.03	0.00
Brooklyn Park 4	17	251	447	J	0.03	0.00
				S	0.92	0.00
				C	0.11	0.00

A shortcoming of this type of analysis is of course that not all jobs are exchangeable. Individuals could in reality also be restricted in their choices of job location by the type of employment that is available. So the distribution on which the null hypothesis is based upon may not be tenable in reality. On the flip side, there are certainly many more locations in the metropolitan area where fitting employment may be found suggesting home-work co-location at the block level may have other mechanisms behind it. Another concern is that intra-household information sharing might also be at play in the extent of co-location that is observed.

It is instructive however to study the relationship between the degree of co-location and the socio-demographic characteristics of the each of the census blocks in the metropolitan area. For instance if locations that have more renters than homeowners show lower co-location, this would be inline with our hypothesis of social network influence. This is because there

is little reason why intra-household effects would be different between renters and owners other things equal. However the degree to which people know their neighbors would be expected to be higher for home owners than for renters. The next section examines the relationship between aggregate socio-demographic characteristics of residential blocks based on the 2000 U.S. census and the level of co-location each block exhibits calculated using the LEHD data.

2.4.2 Home-Work Sharing across Census Blocks

This section will look at how home-work co-location varies across the census blocks in the metropolitan area. Data for this portion of the analysis comes from the U.S. Census Bureaus decennial national census. The variables in our model used below come from the 100-percent characteristics form that is asked of every person and housing unit in the country and released aggregated at the census block level.

The unit of analysis for this portion of the study is the census block unit. As such the H matrix for all blocks contains only 1s and has no variation across blocks except for its size. To compare which census blocks have relatively higher incidence of people working together, we will use the density of the W matrix for the residents of each block.

The density of a network measures what proportion of possible ties are realized. Its value can range between 0 and 1. For a census block with N workers, the density of the work relationship is the count of ties (1s) in the upper triangle of the W matrix divided by $n(n-1)/2$. If everyone in the home block works at the same destination, the density of the W network is equal to 1. If on the other hand everyone in the census block goes to their own unique census block for work, then the density is 0 since no ties are present in the work matrix. Coincidentally, because the entries of the H matrix are all ones, the simple matching, as well as the Jaccard coefficient calculated for a single block are also equal to the density of the work block.

A logit model is used to analyze the relationship between density and block charachterstics. To control for the opportunities that are available from each residence area and the ease of accessing them, gravity based accessibility measures as estimated in (35) for the Twin Cities are used. The gravity based measures use the LEHD number of job reported for each of the blocks aggregated to the TAZ level and uses the reciprocal of the square of the travel time between TAZs for impedance (see (35) for more details). In addition to accessibility measures, racial composition as well as variables that control for demographic characteristics of each block are used. The proposed model is as follows:

$$\rho_b = f(Ac_b, R_b, A_b, H_b, O_b, F_b)$$

where:

ρ: The tie density of the W matrix

Table 2.2: Origin block characteristics

Variable	Description	Category	Percentage
R	Race	White	95.80%
		Black	2.50%
		Asian	1.03%
		Other	0.66%
A	Age	< 30	21.42%
		30-40	48.42%
		40-50	23.18%
		50-65	5.75%
		>65	1.24%
H	Percentage of one person households	> 75%	1.14%
		50 - 75%	4.47%
		25 - 50%	26.52%
		<25%	67.86%
O	Percentage of owner occupied dwellings	>85%	69.90%
		50-85%	16.23%
		25-50%	6.03%
		<25%	7.84%
Total Blocks Used		32494	

Ac_b: the gravity based accessibility measure of the TAZ that the block is in (/1000)

R_b: The majority race in the block

A_b: the median age in the block

H_b: the percentage of one person households in the block

O_b: the percentage of owner occupied households in the block

F_b: the average family size in a block

The distribution of these area characteristics in the study area is given in Table 2.2. In fitting the model, we have controlled for the number of workers originating from the block. The density measure goes down at a much faster rate for each additional individual added to the network since one additional individual means $n-1$ possible ties in the network. Initial fitting of the model showed over dispersion as evidenced by the ratio of the deviance and the degrees of freedom. A scale was estimated by the square root of the the deviance divided by the degrees of freedom. The scale does not affect the estimates but rescales the covariance matrix. The final model is as shown in 2.3.

Blocks that have relatively higher accessibility measures exhibit higher incidences of working together. In part this may be due to the ease of job access that individuals in such blocks have close to them. As the number of opportunities in a particular block grows the possibility of

working at that particular location for any given individuals also grows. After controlling for employment accessibility, interesting relationships between block level demographic variables and home-work co-location.

Although the majority of home blocks are predominantly White, a fraction of the blocks (about 4%) have populations that are predominantly Black, Asian, or "Other" (which includes Native American, Hispanic, or mixed communities). Compared to blocks that are predominantly White, blocks where a majority of the population is Black, Asian, or Other have higher tie densities at the work location. Especially predominantly Asian blocks exhibit larger co-location patterns. Blocks with Black or Other racial groups as the majority also tend to have higher co-location than whites (p-value = 0.05).

The model also illustrates that blocks where multi-person households constitute more than 75% of households have higher work-place density than all other categories (p-value=0.00). No significant difference was detected between the other categories and the base category of greater than 75% single-person households. The finding suggests that location decisions in multi-person households maybe significantly different that in single-person households. This may be because of within-household effects, where people who live together also share a work location, or because individuals with multi-person households have better social networks within their neighborhoods and workplaces that lead to information transfer about jobs/houses.

As the median age in a block group increases, so does the possibility that people who live in that block also share a work block. The estimates indicate that odds of co-location are significantly higher for each age group as compared to the youngest of blocks. With age and experience individuals may better be able to exploit their networks at the neighborhood in getting employment, and may also want to locate closer to contacts that are much like them. They may also be ready to put more weight on neighborhood quality recommendations by others, and less likely to try out a new neighborhood on their own.

Finally, blocks that have a large number of owner-occupied dwellings have significantly higher incidence of people working together. As the proportion of owner-occupied dwellings goes down in a block, the probability that someone will work with another person in their residence block also goes down. This is possibly because home owners, who are likely to reside in their residences longer, form better social networks with those around them as opposed to renters who may relocate much more easily and see themselves as only temporarily in the area. Curiously blocks with less than 25% owner occupied households don't have a statistically significant lower incidence (p-val = 0.11). Blocks that have larger average family sizes also show larger incidence of home-work co-location.

Taken together, these results suggest that neighborhoods with older, predominantly multi-person, owner-occupied households tend to have a higher incidence of co-location at home and work than other neighborhoods. Co-location as measured by the workplace network density is higher in blocks that are occupied by mature and settled households.

Table 2.3: Logit estimate of workplace tie density by census block

Parameter	Description	Categories	Estimate	S.E.	chi-square	p-value
Intercept			-2.953	0.04	6346.14	0.00
N	Number of	25 - 49	-0.666	0.01	4820.49	0.00
	workers	50 - 99	-1.19	0.01	14601.8	0.00
	in block	100 - 200	-1.684	0.01	27088.6	0.00
		> 200	-2.147	0.01	47076.8	0.00
Ac_b	Accessibility		0.012	0.00	199.09	0.00
R_b	Majority	Black	0.033	0.02	3.85	0.05
	race	Asian	0.199	0.03	38.19	0.00
	in block	Other	0.079	0.04	3.95	0.05
A_b	Median age	30 - 39	0.054	0.01	51.6	0.00
	in block	40 - 49	0.091	0.01	81.62	0.00
		50 - 65	0.199	0.02	137.21	0.00
		> 65	0.134	0.03	15.93	0.00
H_b	% of one	50 - 74 %	0.003	0.03	0.01	0.92
	person	25 - 49 %	0.027	0.03	1.09	0.30
	households	< 25 %	0.102	0.03	14.64	0.00
O_b	% of owner	50 - 85 %	-0.029	0.01	12.14	0.00
	occupied	25 - 49 %	-0.05	0.01	21.57	0.00
	households	< 25 %	-0.019	0.01	2.55	0.11
F_b	Family size		0.016	0.01	4.76	0.03
Scale			2.42			

Fit Statistics		
	(Intercept + N term) only	Model
Scaled Deviance	35939.61	35244.27
Logliklihood	-774142.76	-772794.76
Number of observations	32494	

Blocks that are predominantly Asian, Black or Other also display higher incidence of working together. In part this may be due to relatively segregated low-income job opportunities, but coupled with the QAP results earlier, it may also be indicative of communities having mechanisms in which co-location is maintained at a higher degree than predominantly White neighborhoods. Such patterns may in fact be pronounced in areas where new immigrants have settled where they are likely to depend on contacts to find a place of work.

2.5 Conclusion

This research hypothesizes that social networks formed around the home with neighbors or with co-workers are instrumental in finding work and choosing a residential area. We

test this hypotheses using OD data at the census block level for the metropolitan area of the Minneapolis-St. Paul. Quadratic assignment procedure is applied to eight areas in the Twin Cities that each contained several census blocks by defining home and work co-location networks as living in the same block and working in the same block. The findings suggest the observed co-location patterns are not easily replicated when people's work locations were exchanged with one another while keeping their home locations the same. That analysis is followed by a look at how network density as measured by the work place network for residents of each census block in the Twin Cities varies with different demographic characteristics. The findings suggest that co-location is higher in blocks that are occupied by mature households (older, multi-person, home owner dominated households).

The social network paradigm proposed here posits that neighbors and co-workers play an important role in the choice of work and home by passing information about particular opportunities/homes or in general giving guidance on neighborhood quality. Location decisions that arise from these information flows could result in people living and working in closer proximity to one another with more frequency than would be expected otherwise. The results from the QAP analysis support such a hypothesis. Coupled with information about the spatial separation between work and home, understanding and explicitly including such mechanisms of location choice would theoretically improve our ability to predict the matching of origins and destinations. Such findings also give us hope for exploring innovative solutions to encourage car-pooling among people who live and work close to one another, and in job-matching for people who are under or un-employed. Future work should utilize data that has more details and more specific information on relationships than the LEHD origin destination data can provide. Gathering relationship data of this scope is rather difficult and costly. However access to individual level variables could at least help further exploration by redefining relationships not only by census blocks but by demographic classes as well.

Chapter 3

Job Finding Path

3.1 Introduction

Job finding is generally preceded by an active search period to find the best matching position for the searcher. This search process has changed over the last two decades due to changes in technology. How these changes have affected the commute, tenure and relocation for workers is the subject of this and the next chapter. The main change that has taken place in the last decade and a half is the availability of the internet as a search tool to find employment. Its accessibility to a wide range of people has changed how information is sought and compiled. Job opportunities that would have been difficult to know about from outside of a labor market can now be accessed easily by all who have access to the web. Though relocation and transportation costs limit the size of the labor market from expanding to the state or national level, for those that would have been just outside of the geographic limits of the labor market, the internet makes new opportunities possible. From a transportation perspective this could mean longer commutes, or increased rates of relocation.

This chapter looks at how information on jobs is found, and who searches and succeeds in finding employment using a particular search method. Chapter 4 looks into how changes in the way information is found affect home and work locations, as well as relocation and tenure decisions by comparing it to traditional methods of job search. In these two chapters, the changes in technology and the changes in successful job search path over time are studies. In addition hypotheses are presented and tested about the complex relocation decisions by households after finding work and how employment finding means influence these decisions.

Information from contacts, newspapers, recruiters, and the internet can be utilized to different degrees by different searchers in finding employment. Depending on the type of labor market that an employer is located in and the employment opportunities it has, its advertising strategies will be different. For instance employers with low skilled job opportunities

may choose to avoid recruiters, or rely on community bulletins and local newspapers. On the other hand, the internet may be a more suitable medium to recruit people who would have to use a computer in an office environment, for technical people, or to recruit for positions from a wider set of backgrounds. Employers can also use a mix of these of these recruitment venues.

The search path that one decides to follow impacts what is available to them. The number of opportunities, their locations, and the likelihood of successful placement depends on which methods one decides to use. For instance a local newspaper would mostly have local opportunities, recruiters may be confined to particular employers or industries. On the other hand the internet can provide information from a much larger set of employers covering a wider geographic area, but the plethora of information can make success and finding a good match dependent on the proficiency of the searcher.

Due to the wide use of the internet by both employers and job seekers since the mid 1990s job search methods have changed significantly. This change in technology presents significant advantages to the searcher. It reduces the search cost and expands the set of possible opportunities. A searcher can narrow alternatives based on job description, or more specific criteria, as well as on geography, limiting searches to those opportunities that are near their home. Once an individual has access to the web, changing the geographic scale of search or other attributes has minimal costs allowing them to access information that would otherwise have been costly by any other method.

The opportunities that the internet provides also provide new challenges. The ease of access to the internet means that the same information is available to a wider pool of people, which can make the competition for a particular position much stronger than it would have been had the labor market been confined by the reach of traditional search tools. Alternately, the expansion of the set of opportunities at very little search cost might lead one to finding more jobs at distant locations that otherwise would not have been considered, requiring longer commutes, or the need for relocation.

To look into the complex responses that arise as a result of the changes in the search process and its impacts on home and work locations, we undertake a survey of residents in the Twin Cities area in two phases. The survey focused on work finding, relocation, the role of ICT and social contacts, as well as the social travel that respondents participated in. In the following section we will discuss the survey and data collection and follow that by an analysis of work finding methods. In Chapter 4 we will look at relocation decisions that follow job finding. The social travel data will be the topic of Chapter 5.

3.2 Survey and Data

A two phase web based survey was administered to gather data on job finding, home finding, the meetings that people participate and the social and technology networks that help them

in the process. Respondents were recruited through mailed postcards. Recruitment postcards were sent to eight zip code areas in the Twin Cities to 5000 people in each of the two phases. The areas selected are shown in figure 3.1. The areas were chosen to have an economic and racial mix of respondents, as well as a city and suburban mix in the respondent pool. Reminder postcards were sent a week following the original mailing.

The survey was internet based and invited respondents were asked to login to the survey with a unique code placed on the mailed postcard. The survey participant had to be a working adults in the household. Respondents were asked to not complete the survey if they did not satisfy this criteria. The survey also offered a $5.00 coffee card to participants who completed the survey as well as a chance to be included in a drawing for an iPod Touch for one randomly selected respondent in each phase.

On first mailing 192 and 205 cards were returned due to wrong addresses from each phase. Overall there were 268 and 297 respondents in phase 1 and 2 respectively (5.88% of postcards that reached their destination). The response rate for the survey was low and perhaps could have been increased by repeated solicitation to the respondents. In addition, because the questions went into the details of people's contacts and daily schedules, privacy concerns may have led some to drop out or skip questions that they were not willing to answer. Another possible reason for the low response might be availability of a computer and access to the internet in lower income areas.

The postcard mailer is shown in Appendix A. Screenshots from the survey are included in Appendix B. The decision to go with postcard mailings and to have an online survey were factors that were mainly influenced by cost.

The distribution of demographic variables among the respondents and that for the State of Minnesota is given in Table 3.1. Overall the sample shows bias towards women, and more highly educated individuals as compared to the demography of the State's population.

Broadly speaking, the survey focused on four areas. The first section dealt with the experience of the respondent during their last job search. Respondents were asked how they found their job, including whether contacts were used, and if so, details on the contact. The second section dealt with their residence, including when they moved and what their reasons for moving were, the third section dealt with the respondent's social network and what their weekly social meeting looks like. The survey ends with questions about the respondent's commute and demographics.

3.3 Job Finding and Changes in Technology

Respondents were asked to specify how they found their current job. In this study, job finding paths are classified into four groups by the information source the searcher used to find employment. The categories are formal, internet, newspaper, and contacts. The formal

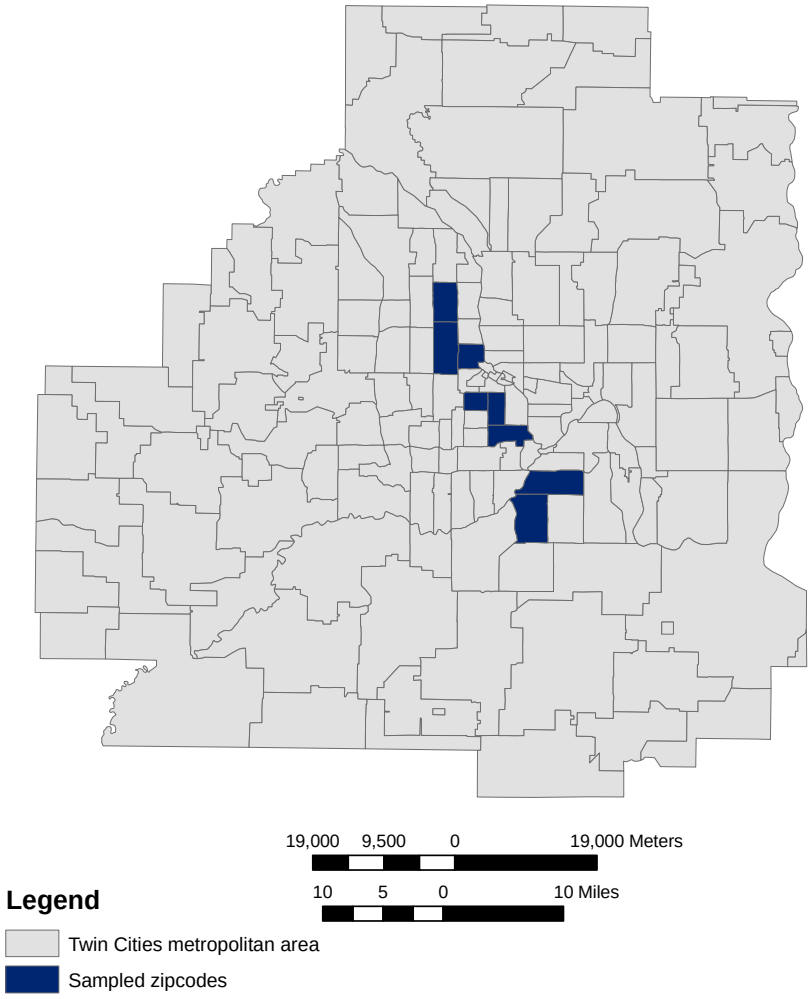


Figure 3.1: ZIP Codes of residents to whom recruitment postcards were sent in the Twin Cities metropolitan area

Table 3.1: Summary of survey subjects

Variable	Group	Survey	Minnesota
Sex	Male	39.8%	49%
	Female	60.2%	51%
Age (MN data for those between 18-65)	mean	38.9	39.2
Household	Renter	22.5%	25.4%
	Owner	77.4%	74.6%
Education (MN data for those 25 and older)	Less than high school	0.4%	9.3%
	High school	16.6%	50.6%
	Associates degree	14.1%	9.6%
	Bachelor's degree	45.7%	20.8%
	Grad/Professional degree	23.1%	9.6%
Household Income	Mean	$ 76,550	$ 81,644
	Median	$ 68,000	$ 66,809
Race	White	90.3%	89.4%
	Black	3.4%	3.5%
	American Indian	0.2%	1.1%
	Asian	3.2%	2.9%
	Other	3.0%	3.1%

category includes the use of recruiters, employment agencies, using job fairs, temp to hire agencies, and application mailing. contacts can be friends, families, colleagues, etc.

By far, the use of contacts is the primary method of job finding in our sample. Excluding the self employed, contacts make up over 40% of the reported job finding path. Figure 3.2 shows the share of each medium in our respondent pool, categorized by when the respondent started their current work. In each time category, contacts have held their share steady even as technological changes have taken place. On the other hand, the share of employment that people find using newspapers and formal searches has declined as the internet has picked up a significant proportion of the job finding market. The technology however has not been able to make a dent into the share of employment that is found through contacts over time.

While the share of jobs found through the internet is increasing, this number is much smaller when compared to the proportion of people who report they would use the internet as their primary job search tool if they were searching now. Of the respondents that are not currently self-employed, 66.3% responded that the internet would be their primary tool for job finding (N=475). In contrast only 22.1% of those who started their current job since 1995 (N=417) report using the internet to find their current employment. Of those that found their current job from January 2005 and on (N=207), the share that found it via the internet is 30.9%, which is less than half the 74.6% in this group that report would use the internet as their primary search tool. The comparable proportions for using contacts are

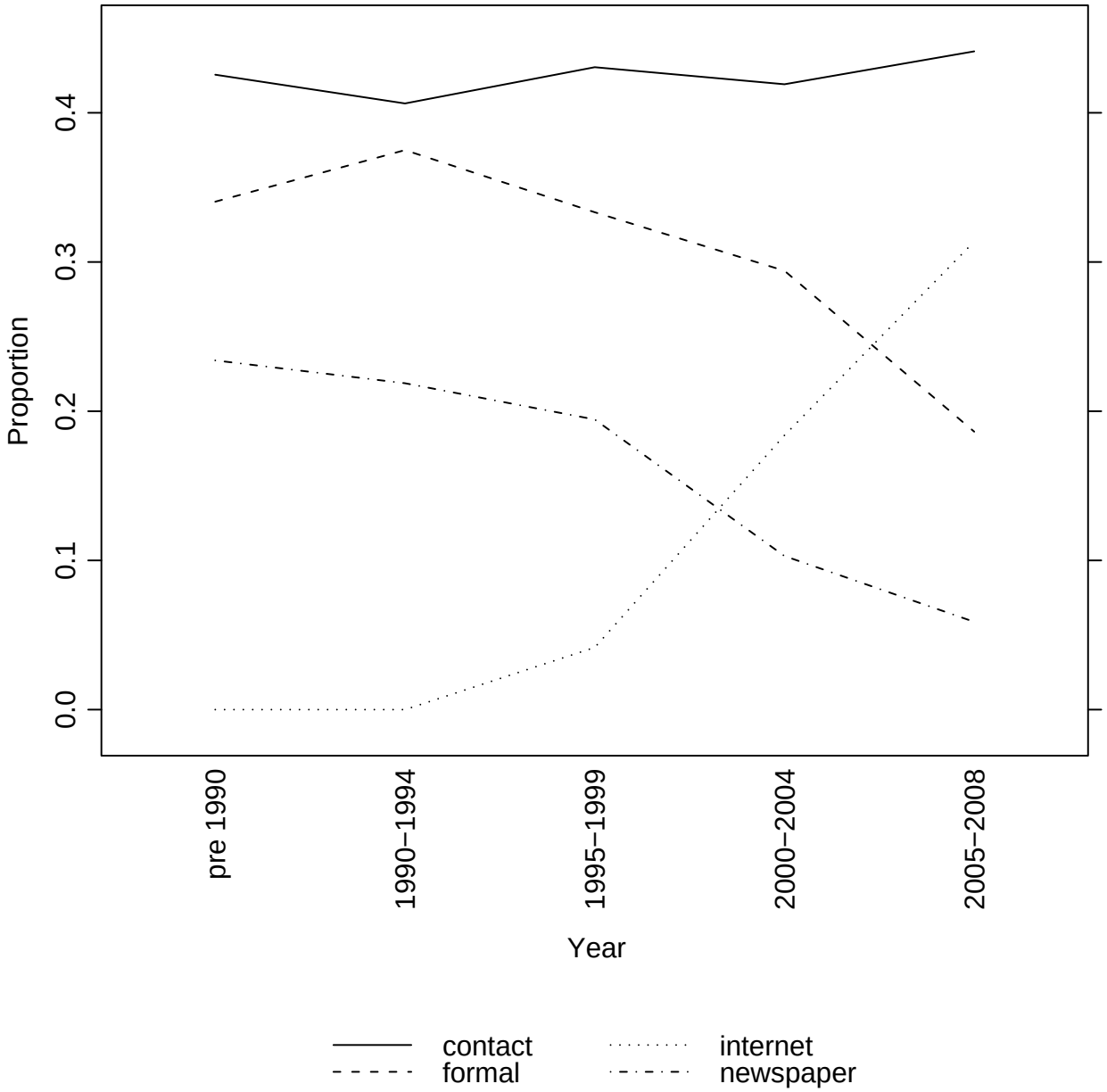


Figure 3.2: Job finding strategy proportion by year

18.3%, 42.7% and 43.4% for those that would use contacts primarily, used contacts since 1995, and used contacts from 2005 and on respectively. Table 3.2 presents these proportions for each search path.

These numbers demonstrate that because of its low cost and ease of access, the internet dominates as the tool of choice for job searches. However it is rather inefficient (at least as compared to contacts) in leading to successful employment. Feldman and Klass (36) highlight some of the challenges of using the internet for employment including the web-skills of the searcher, content of announcements, recruiting practices, and lack of followup among others.

When it comes to contacts, over twice the number of people that would use it as a primary search method found employment that way. The personal recommendation of a contact known both by the employer and the job seeker can give assurances to both searcher and the employer and lead more successfully to employment. Of course, use of the internet has other advantages that the job seeker can exploit in their employment regardless of whether their search through the internet was successful. They are able to learn more about the market in which they are competing, the going wage for their experience level, and other information relating to successfully getting employment. In this way the internet both competes with (most successfully with newspapers) and complements the other job search paths.

Table 3.2: Primary job search method vs. job finding

	primary job search (if searching today)	Proportion of people that found their job before 1995	1995 and later	2005 and later
contact	18.3	40.2	42.6	43.5
formal	9.3	34.1	24.5	18.4
internet	66.3	0.0	22.1	30.9
newspaper	4.4	22.0	9.6	5.8
other	1.7	3.7	1.20	1.4
N	475*	82	417	207

* 24 individuals did not respond

Recognizing that changes in job finding have taken place, the following sections will explore if these changes have implications on the location of job found, and on residential relocation decisions afterwards. To accomplish this, the differences among individuals in effectively using one search path over the other towards successful employment is studied first. In chapter 4 the sample is divided into individuals who found their current work while at their current residence, and those that have since relocated to a new home. The two groups will be used to compare the distance outcome of job search, and the relocation decision that follows job finding.

3.4 Social Networks, Technology and Job Finding

The search path followed by each individual depends on the resources they have at their disposal. It is likely that the easiest starting point is the least costly option at the time. The decision also depends on the person's characteristics at the time of search. While there maybe a personal preference to one search method or another, there is little reason for a searcher to not employ all paths given they are available. While different paths may bring different types of opportunities, acceptance of an offer will depend less on path than the contents of the offer. The exception here might be when contacts are involved, in which case the path could play a deciding factor between alternatives where the offer attributes are reasonably close.

Using a multinomial logit model we explore which variables are important for success of one path over another in our sample. The dependent alternatives are the use of contacts, internet, formal means, or newspaper. These are modeled as depending on the person's characteristics, the size of their social network and their network's geographic proximity to their residence, how long ago the search took place, and whether or not they were employed at the time of their search.

We specify the multinomial choice model as follows:

$$P \sim f(S, E, I, A_j, Y_j, E_m, C_s, C_{p3})$$

where

P: Job finding path for current employment

S: Sex

E: Education

I: Household income

A_j: Age at the time of starting current job

Y_j: How long ago was the job search done (years)?

E_m: Was the person employed at the time?

C_s: Number of close contacts (interact with twice a month or more, and don't live in the same house as you).

C_{p3}: What proportion of these contacts live within 3 miles of your current residence?

Some of the variables may have changed for the subjects since their days of finding employment. This is especially true for subjects who have been employed at their current job for a long time or those that have relocated. The estimated model is reported in table 3.3.

The base alternative against which the odds are estimated is the likelihood of using contacts. Sex, household income, and age at the time of employment do not describe the successful

job path process for the sample. The successful job search path depends on education, time elapsed since search (technology change), whether a person was employed at the time of search , and in some cases the size and proximity of their social network.

Table 3.3: Multinomial model of job finding path

		formal			internet			newspaper		
Variable		est.	s.e.	p-val	est.	s.e.	p-val	est.	s.e.	p-val
(Intercept)		-1.07	0.78	0.17	-0.30	0.87	0.72	-2.72	1.24	0.03*
S	Male	-0.41	0.27	0.13	-0.46	0.31	0.14	-0.19	0.35	0.59
E	Associate	0.18	0.49	0.70	0.70	0.60	0.25	1.11	0.57	0.05*
	Bachelors	0.76	0.38	0.05*	1.31	0.50	0.01*	0.62	0.51	0.23
	Graduate	1.11	0.43	0.01*	1.02	0.56	0.07	0.77	0.59	0.19
I	30-49.9K	0.12	0.72	0.86	1.07	0.81	0.19	0.94	1.17	0.42
	50-74.9K	-0.28	0.71	0.69	0.45	0.81	0.58	1.12	1.13	0.32
	75-124.9K	-0.22	0.70	0.75	0.54	0.81	0.51	0.70	1.14	0.54
	$\geq$ 125K	-0.76	0.79	0.33	-0.25	0.98	0.80	-0.19	1.28	0.88
A_{js}	30-39	0.11	0.30	0.72	-0.07	0.37	0.85	-0.29	0.42	0.49
	40-49	0.04	0.40	0.92	-0.49	0.50	0.32	0.41	0.47	0.39
	$\geq$50	0.29	0.52	0.58	-0.08	0.54	0.88	-0.09	0.74	0.91
Y_j		0.04	0.02	0.02*	-0.23	0.05	0.00**	0.06	0.02	0.01*
E_m	Yes	-0.54	0.27	0.04*	-0.47	0.31	0.13	-0.47	0.35	0.18
C_s	6-15	0.90	0.40	0.03*	-0.34	0.42	0.42	0.14	0.48	0.77
	16-50	0.53	0.44	0.23	-0.51	0.46	0.27	-0.43	0.56	0.44
	$\geq$50	0.25	0.83	0.76	-0.31	0.87	0.72	-0.21	0.98	0.83
C_{p3}	1-10%	-0.78	0.55	0.15	-0.40	0.63	0.53	-0.10	0.76	0.90
	10-25%	-0.41	0.34	0.23	-0.31	0.39	0.43	-0.09	0.46	0.84
	25-49%	-0.28	0.36	0.44	-0.18	0.41	0.67	0.12	0.49	0.81
	$\geq$50%	-1.69	0.83	0.04*	-0.56	0.71	0.43	-0.09	0.76	0.90

Model statistics			
Obs	415	LR $\chi^2(51)$	113.48
$pseudo - R^2$	0.116	$Prob > \chi^2$	0.000

Significance: * $\leq$ 0.05 **< 0.01

All other things equal, Bachelors degree holders have the highest odds of successful job placement using the internet, followed by using formal means. Those with graduate degrees have the highest odds of success by using for formal means, followed by the internet, and those with an Associate degree have the highest odds of using the newspaper as their path to a job. The odds of using the internet successfully is highest for Bachelor's degree holders. More specialized positions that require more than a Bachelor's degree are best served by recruiters. The market for such positions is also likely to be narrower, hence the higher success rate by using a specialized searcher in particular industries. The model also suggests that for sectors that employ people with educational levels less than a Bachelor's degree, the

best recruitment path is the newspapers. Levels of access to the internet may be depressed in this education class, searching skills online may not be as developed, and as a result employers might be more inclined to use the traditional advertisement strategies they have been using in the past.

Whether or not the person was employed while searching for their job is also important in the choice process. All things equal, a person who is employed is more likely to get their next job through a contact than through formal means (p-val=0.04), the estimated signs for *internet* and *newspaper* searched also indicated that contacts work better than both methods when a person is employed. This can be a result of people who are employed having more contacts who are also working in their field and therefore can access those contacts for jobs. In addition, referrers may be more comfortable recommending a contact who is already employed and has active experience.

As expected the time to employment is also important as it accounts for the advantages of each path at different times. The higher the number of years elapsed since finding their current job, the less likely the person used the internet to find employment. The likelihood of employment using formal means and the newspaper increases as the time to when the employment decision was made gets longer.

Both the size of the searchers social network, measured as the number of people they keep in touch with at least twice a month that do not live in the same house as them, and proximity of that social network, measured as the proportion of contacts who live in a 3 mile radius of the respondent, were included in the model. The model estimates suggest that size of social network (C_s), as measured here, is not an important indicator of job search path except of those with a smaller social circle (6-15). This group was more likely to use formal means than contacts. In all other cases the size of the social network does not influence the search path.

When the proportion of close contacts that live in a 3 mile radius exceeds 50%, that person is much more likely to use contacts rather than formal means for job finding. In all other cases, the findings do not show statistically significant relationships between geographic proximity to a large number of contacts and the successful job search path.

3.5 Summary

This chapter looked at the job search search process and how it has changed over time. Within the sample that was considered, job finding through contacts has held a relatively steady proportion of jobs found. Newspapers are loosing ground to the internet. As for the internet, while it is cited by many as their primary tool for job search, its potential for successful employment among primary users is found to be less than that of contacts.

The analysis highlights the following points. After controlling for time effects and all other

things equal, education level and employment at the time of search are important indicators of what path is followed. Both of these variables have directions that was expected. The social network variables, size (C_s) and the percentage of close contacts in a 3 mile radius (C_{p3}) show a mixed pattern. These variables matter in two cases: (1) when the social network size of the respondent is small, formal means are more likely to have been used than contacts, and (2) when the proportion of contacts in a 3 mile radius of the respondent's home exceeds 50%, use of contacts is more likely than formal means. In other cases, the social network variables have no detectable impact on the successful path the subjects followed.

Chapter 4

Job Changing, Home Relocation and Commuting

4.1 Introduction

This chapter looks at the changes in home-to-work distance and travel time after finding new employment by comparing how it varies across respondents and the search path they used to find work. Different factors can influence the home-to-work distance job seekers would consider reasonable when trying to find work. Household composition, employment status at the time of search, demographics, current living conditions can all have varying degrees of influence.

Renters and home owners likely have different tolerances for new commute distances. Household responsibilities can also affect what is readily accepted. Longer commutes could mean less time to spend at home, or can affect other activities that have fixed time. For example, having to pick up a child from a childcare facility by a certain time can easily require the exclusion of certain locations as possible work sites without changing childcare arrangement. In addition, people who are attached to their homes or neighborhood may be reluctant to accept very long commutes when comparable employment alternatives are present at shorter commutes. Others in the same group may be willing to accept longer commutes while staying in their homes if other employment alternatives are not available to them.

In addition to such household, demographic, and economic constraints, the search path to finding employment may also play a role in the geographic location of employment. Differences in search methods are hypothesized to influence location because of the way in which information is gathered by each search medium. For instance one can compare the breadth of the search geography when using the internet with that of using contacts, local newspapers, or doing walk-in applications.

Certainly, not all jobs that are found by searching the internet are farther out, and not all

opportunities that are farther out are accepted. Ultimately the searcher makes the decision on what opportunities to pursue and accept. However, that certain opportunities can only be accessed (or be better accessed) by one search medium and not others given the geographic location of the searcher alters the choice set from which opportunities are pursued. It is this distinction in home-to-work distance that may arise from employing different search paths that we wish to uncover in the first part of this chapter.

The second part of this chapter, deals with decisions that are made after a job searcher has found employment. In particular we wish to understand the effect the job search path (either directly or indirectly) has on subsequent relocation decisions such as how soon they relocated, their new commute, and how far from their previous residence they move. Differences may arise because the home to work distance outcomes from some search paths maybe longer than others. They may also be a result of the implied job security because of the search medium (for example when using contacts). Relocation decisions are seldom made solely based on commute considerations. Factors such as neighborhood quality, other activity locations, schools and so on also play important roles.

In addition, factors such as the number of contacts the relocating household has in close proximity can also influence the specifics of how far away one relocates from their previous location. People who want to stay close to their local contacts may not move as far away as others from their previous location. Consequently they may trade closeness to these contacts with by foregoing a reduction in their commute.

4.2 Employment Search Path and Commute Outcomes

To uncover the relationship between search path and commute outcomes, the current home-to-work distance and travel time are modeled as a function of whether the respondent owns or rents their current residence, the method of job finding, the age of the person when taking the job, and the number of years they had spent in their residence at the time of taking the job.

This model is applied to individuals who have not yet relocated after finding their current work. This would mean individuals who have relocated because their commute was onerous for example would be excluded. If indeed particular search paths were associated with some paths, it would make this model conservative it its estimation. Dummy variables are also used to control for different suburban home locations. The proposed model is as follows:

$$D_{hw} \sim f(R_c, J_f, J_i, J_n, I, A_j, E, H, Y_{hj}, NW, SE)$$
$$T_{hw} \sim f(R_c, J_f, J_i, J_n, I, A_j, E, H, Y_{hj}, NW, SE)$$

where:

D_{hw} : Home-to-work distance (dependent variable for model 4.1)

T : Home-to-work travel time (dependent variable for model 4.2)

R_c : Do you currently rent your residence? (yes=1)

J_f : Job found through formal means

J_i : Job found through the Internet

J_n : Job found through newspaper ads

A_j : Age at the time of taking job

Y_{hj} : Number of years at current residence at the time of taking the job

NW : Dummy variable for home location in the north west suburbs of the Twin Cities

SW : Dummy variable for home location in the south/south east suburbs of the Twin Cities

The estimated model is given in Tables 4.1 and 4.2.

In the distance model (Table 4.1), the variables of household income, age at the time of taking the job and household size are not significant and do not explain the variability in the data. As hypothesized, among those who have not yet relocated after finding work, the renters live farther from the employment location than do home owners. This is likely because renters can relocate easily to new locations, and can adjust their travel time at the time of relocation.

Job seekers that used the internet and the newspaper to find work both have longer home-to-work distances than do those that used formal means and contacts (p=.064 and p=.055 respectively). This is likely due to the variety of information that is gathered by the internet and newspaper. Whereas a recruiter can specialize in one geographic area, or be told to look for opportunities in a particular area, identifying these locations while using the internet or newspaper would require the searcher to sift through information personally and could bring new opportunities to the fore. The mean home-to-work distance for internet users is higher by 2.4 miles and for those using newspaper, it is higher by 3.3 miles. The possibility that using formal means was more suited to one type of area over the other was tested using the data (for example the CBD and using recruiters etc.) but no association was found between search path and distance of the employment location from the CBD.

The other variable that was significant was the dummy for the northwest suburb. Respondents living in this area reported higher home-to-work distance than respondents in the City of Minneapolis or in the southeast suburbs. The reason is likely related to the thinner job density in these locations relative to the center and southern parts of the metro area. Home tenure before finding the new work location has the expected negative sign, indicating those that have lived in their homes (and neighborhood) longer opted for closer work opportunities (p=0.107).

Looking at the travel time model (Table 4.2), though the signs and tendencies exhibited

by the model estimates are similar to those in the distance model, many of the statistical significances are absent. For example internet and newspaper users still have positive relationship with travel time (p=0.256 & p=0.122 respectively), renters show a higher travel time than owners (p=0.156) and those in the northwestern suburbs report higher travel times (p=0.139). While distance and travel time are correlated, travel time depends on variables such as capacity and demand on the routes between home and work, and in some cases places that are farther can be reached much faster than places that are geographically closer due to differences in demand and capacity.

Table 4.1: Home-to-work distance (miles) after finding new work

Variable		Estimate	Error	t value	$Pr > \|t\|$
(Intercept)		4.605	2.673	1.720	0.087*
R_c	Renter?	3.371	1.233	2.730	0.007**
J_i	Job internet	2.399	1.288	1.860	0.064*
J_c	Job contact	-0.037	1.209	-0.030	0.976
J_n	Job newspaper	3.278	1.698	1.930	0.055*
I	Houshold income	-0.052	0.110	-0.480	0.634
A_j	Age job taken	0.008	0.052	0.160	0.874
E	College degree?	1.291	0.969	1.330	0.185
H	Household size	0.288	0.330	0.870	0.384
Y_{hj}	Home tenure	-0.114	0.070	-1.620	0.107
NW	Northwest suburb	2.967	1.190	2.490	0.014**
SE	Southeast suburb	1.153	1.148	1.000	0.317
Analysis of variance					
Source	Df	Sum of squares	Mean square	F value	$Pr > F$
Model	11	1014.59	92.24	2.99	0.0012
Error	163	5029.62	30.86		
R^2		.168			
Significance *** 0.01		** 0.05	* 0.1		

Overall, the distance model suggests that job finding paths have unique characteristics that would lead to different home-to-work distances. The use of contacts and formal means such as recruiters leads to locations that are on average closer to the searcher than do using the internet or newspaper. On the other hand, based on our data this distinction in distance is not reflected in the travel time data though the trends are similar.

The differences in distance along with other household demographic and economic constraints can influence relocation decisions or the location decisions once the decision to relocate has been made. To study the possible relationships between job finding and decisions of residence afterwards (stay/move, stay for how long, and if moving to where?) the next section will focus on the survey participants that have relocated their residence since finding their current work.

Table 4.2: Home-to-work travel time (minutes) after finding new work

Variable		Estimate	Error	t value	$Pr > \|t\|$
(Intercept)		12.283	3.464	3.55	0.001***
R_c	Renter?	2.286	1.605	1.42	0.156
J_i	Job internet	1.901	1.666	1.14	0.256
J_c	Job contact	-0.251	1.556	-0.16	0.872
J_n	Job newspaper	3.449	2.218	1.56	0.122
I	Houshold income	-0.099	0.141	-0.7	0.485
A_j	Age job taken	0.029	0.067	0.44	0.659
E	College degree?	1.311	1.254	1.05	0.297
H	Household size	0.049	0.430	0.11	0.909
Y_{hj}	Home tenure	-0.175	0.090	-1.95	0.053**
NW	Northwest suburb	2.283	1.536	1.49	0.139
SE	Southeast suburb	-0.969	1.475	-0.66	0.512
Analysis of variance					
Source	Df	Sum of squares	Mean square	F value	$Pr > F$
Model	11	953.65	86.70	1.7	0.077
Error	161	8201.93	50.94		
R^2		.104			
Significance *** 0.01	** 0.05	* 0.1			

4.3 Commute Outcomes of Relocation After Finding Employment

Residential relocation decisions are much more deliberate than most other location decisions. These decisions can be motivated by a range of issues that have to do with changes in household structure, economic changes in the household, changes in the neighborhood etc. In addition to these factors, Clark and Withers (37) do find that job changes can also serve as a trigger to housing relocation decisions. They find the effect of a job change is especially strong for single renters and weaker in two worker households. Clark and Burt (38) also note a higher probability to relocate when the home to work distance is long. In this section relocation outcomes after finding work are studied, along with different attributes of the relocating household that inform the relocation decisions. In addition to the usual demographic and commute related variables, we also study the role that social contacts play in informing the location choice.

Selection of a new location upon relocation often has to balance competing needs of the household. Commute is one part of the consideration, but it is not the only one. For example Giuliano and Small (39) find that the actual commute distribution is greater than what would be expected had people made commute minimizing location choices.

According to a 2004 mobility report by the Census Bureau (40), most people reported relocating due to housing related reasons (51%) or family related reasons (26%). Work related reason were reported as primary by 16% of respondents. A significant portion of these reported moving to a better home/apartment (20%), moving to own a house (10%), or a new job or transfer (9%). The survey, which allowed for only one response per individual, did not consider secondary or tertiary roles played by commute distance/time in narrowing down a location among possible alternatives. There are often many locations that can satisfy only one location consideration. In such cases, secondary reasons can play an important roles to refine the location choice.

In the web based survey administered for this study (see Chapter 3), the primary, secondary and tertiary relocation reasons cited among all respondents are given in table 4.3. The primary reasons most often cited by the respondents are cost of the unit and affordability of the area followed by closeness to work and closeness to family and friends. Aggregated together home and neighborhood related reasons make up a majority of the reasons cited. "Being close to work" is cited frequently as one of the top three reasons for relocation with 36.7% of respondents whose previous home was in the metropolitan area of the Twin Cities selecting it. Figure 4.1 shows the previous-home-to-work and current home-to-work distances. It is clear that many maintain or reduce their commute distance upon relocation. The figure also shows that most of those that cited commute as a reason for relocating did reduce their home-to-work distance from what it would have been had they not relocated.

Evidence that many household maintain their commute upon moving is also presented in a case study of the housing changes of employees at a Southern California firm (41). The authors find that trip lengths of the employees did not increase substantially over a period of six years. Looking at how commuting distances change, Clark et. al. (42) find that households that have high commutes to begin with shorten their commutes, and that women were more likely to shorten their commutes after a move than men. The stability of travel times over a long period of time is observed as the employment landscape in major metropolitan areas has been changing by suburbanizing jobs and housing. This stability has been explained as arising from rational location decisions both by firms and individuals to keep travel time constant (43). Levinson (44) has also posited that the increasing accessibility that arises from jobs that have followed suburbanizing homes has helped create this stability.

Relocation after finding employment can be an immediate or long term consideration. How soon relocation takes place can depend on the circumstances of the relocators' residence (rent/own, location etc.) and life style and household characteristics at the time of employment as well as the characteristics of the new employment affect this decision. For instance a renter who found employment farther from their rental unit may find it easier to relocate to accommodate the new commute than a home owner. Larger households, or dual earner households may find it more difficult to relocate. A person planning to buy a house next may find the costs of immediate relocation not worth any of the benefits relocation provides. Those who like their neighborhood, or have numerous local friends may opt to not relocate or relocate closer to their previous location while achieving the other goals of relocation.

Table 4.3: Top three reasons for relocation among those whose previous home was in the Twin Cities metropolitan area (percentages)

	Reason 1	Reason 2	Reason 3
Cost of living/affordability	27.89	21.09	13.83
Close to work	17.01	12.93	8.16
Close to family/friends	10.43	12.47	7.94
Bike friendly area	0.23	1.36	2.49
Close to transit	1.13	2.49	2.27
Close to the city	14.74	14.06	12.7
Close to church	0.91	2.04	1.13
Close to open spaces	2.95	6.58	8.62
Larger lot size	1.59	1.81	3.17
Away from the city	0.68	0.23	0.91
Residence unit features	7.94	5.44	6.35
Safety	1.81	3.17	3.63
Kid friendly neighborhood	1.36	3.4	5.67
Good school district	3.17	2.04	2.72
Investment value of home	2.27	3.4	6.35
Other	2.04	1.81	1.36
Unreported	3.85	5.67	12.7
Count		441	

Age, income, household size and so on which influence the lifestyle of the decision makers can also have impacts on relocation considerations.

The last section showed the relationship between commute distance and job finding methods. Similarly, job finding methods can also play a role in relocation decisions because of the distance outcomes that they lead to. For example the longer distances of internet and newspaper found jobs may lead to relocation to adjust the commute. Another reason that job finding methods may be important is due to their employment outcome. For instance some research has shown employees who found their jobs through contacts to be paid more at least initially (45; 46), and that they also have a longer tenures (46). The sense of security in the position that may arise from the job finding path may encourage individuals to make lifestyle changes more quickly than they otherwise would.

Among the competing considerations that relocating households have, this section hypothesizes that individuals with larger social contacts in their neighborhood are less likely to move, or when they move they are more likely to move shorter distances away from where they were as compared to those that have fewer contacts in close proximity. Alternately as well individuals that have a large circle of close contacts around the metropolitan area are expected to relocate more freely.

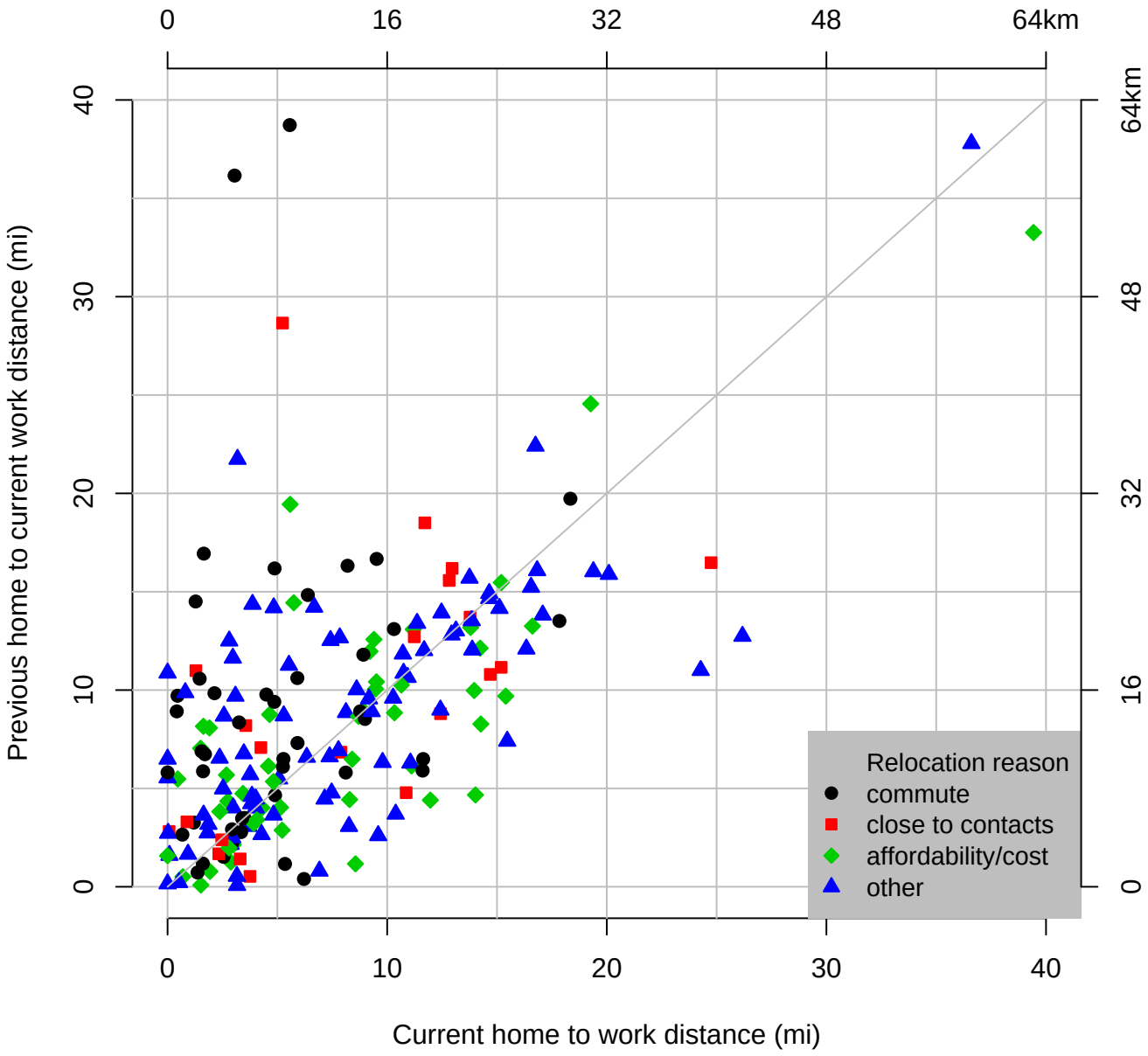


Figure 4.1: Distance between home and work before and after relocation for individuals who have relocated since finding their current work.

4.4 Analysis

In this section, we hope to uncover the relationships between job finding, tenure before relocation, new commute and how far away people relocate from their previous location using variables reported from the survey discussed above. The influence of job finding methods, social contacts, household and personal variables and the interdependence between how long after job finding the person relocates, the new locations distance from the previous home and the new commute are explicitly considered. The relationship between these variables can be studied using path analysis.

Path analysis has its origins in biology in the work of Sewall Wright (47; 48; 49; 50). Wright first used the method in linking the degree to which heredity and environment affect the color of guinea-pigs' offsprings (47). The method has often been called causal modeling, however, as Denis and Legerski (51) point out the case for causality has to lie outside of the statistical modeling technique.

Wright (52) describes path analysis as:

> "...a way of dealing with interrelated variables. It is based on the construction of qualitative diagram in which every included variable, measured or hypothetical, is represented (by arrows) either as *completely* determined by certain others (which may be represented as similarly determined) or as an *ultimate* factor."

The method is one where a hypothesized set of relationships that are dependent on one another can be tested.

Path models employ both standardized and absolute (measured) variables in estimation. For the standardized estimates, each of the variables is adjusted so that its mean is zero and its standard deviation is equal to one. The standardized estimates of the path model give how many standard deviations the endogenous variable moves in response to a change in one standard deviation of the exogenous variable when all other variables are held constant. The regression coefficients, estimated from the observed variables, measure the contribution of each of the independent variables on the dependent variables.

Miller (53) summarizes the assumptions behind path models as follows:

- change in one variable is always a linear function in the change of another variable .
- there is no reciprocal causation.
- one must be able to prioritize the ordering of effects (tease out the primary effect from the indirect effect).
- the disturbances of the dependent variables are uncorrelated
- the usual assumptions in regression analysis are met (independence, homoscedasticity etc.)

The hypothesized relationships between individual characteristics, job search, tenure at home, commuting distance, and different outcomes of the relocation decision is shown in figure 4.2. Relocation decisions after finding new employment are hypothesized to take time after finding work. This time is expected to be influenced by the persons' living arrangement, how they found their job, their age, what kind of move they aim to make, as well as their commute to the new work location. Younger individuals, as well as renters are expected to relocate faster. Individuals who aim to rent next are also expected to move sooner than those who aim to purchase their next residence.

The longer their commute to their new employment, the quicker individuals are expected to relocate. If the job was found through a contact, relocation is expected to occur sooner because of the implied confidence in the security of the new job. Individuals who found their job through the use of internet and newspaper are also expected to relocate sooner relative to those using formal means.

In choosing their new location, individuals with smaller households are expected to be able to lower their commute than those with larger households who have to balance competing commute and location requirements. Those with larger incomes are expected to be motivated by other considerations such as larger homes and lot sizes which imply locations farther out from employment centers, and hence longer commutes.

Individuals whose commutes become longer when finding new employment are expected to lower or maintain their previous home-to-work distance upon relocation. In addition, those individuals who relocate sooner are expected to lower their commute than those that stay at their current location under the new commute. In this arrangement, the commute right after relocation is expected to impact the new home-to-work distance directly, and indirectly through their tenure at their previous location.

Another consideration in relocation is also how far away from their current neighborhood a household relocates. Naturally the longer they have lived in the neighborhood, the more they know about it relative to other areas and the more attached they would be to it. How far away relocation occurs in this case is expected to be negatively impacted by home long after finding work, the relocation takes place.

In addition, the number of contacts a person has in their neighborhood can negatively influence how far away they relocate if closeness to these contacts is important to them. Alternately if an individual has a large number of contacts spread across the metropolitan area, it could mean that they have opportunities to relocate at locations that are farther from their current neighborhood while maintaining closeness to a desirable number of their contacts. The number of contacts a person has and the percentage of contacts in a 3 mile radius after relocation are used as indicator variables to how many local and total contacts the respondents had at their previous location.

The path model shown here encapsulates decisions taken over a long period of time. Job finding is the earliest event, and relocation is the latest event. These are separated by

the tenure at the previous location after finding the current job. The age at which the current job was found and the years spent at the previous home add up to make the age at relocation. The new home-to-work distance and the previous home-to-current-home distance are outcomes of the latest decision.

In light of these time differences it is essential to establish which variables are from the time of the decision and which are not. Household size, household income, and household vehicles are from the time of the survey, and should be taken as indicator variables of lifestyle at the time of the decision. Just over 54% of the relocations considered here have occurred since January of 2004, and a further 20% since 2000. The number of contacts (C_s) and the percentage of contacts within three miles of home (C_{p3}) are variables reported as of the time of the survey, and these should be considered as indicator variables of how many total close contacts a person has and how many of those are in close proximity to them.

A path model was estimated for the relationships proposed in figure 4.2 using the CALIS procedure of SAS software (54). The final estimated model is shown in figure 4.3. Many of the hypothesized relationships hold while a few are found to be not relevant or having the opposite direction.

Contrary to what was expected, older individuals relocated faster than younger individuals. For each additional year a person is older when taking a new job, tenure at their older home decreased by 1.98%. Individuals that would relocate to a rental unit spend 27% less time at their residence than people who purchase their next location, and those that were renting their residence at the time of finding work relocate 36% sooner than home owners. Owners are more committed to their residences, and the costs of relocation are much higher to them than to renters. Those who plan to own also take longer to relocate because the home search takes planning and time. Since home ownership involves risks that renters do not endure, getting into the "right" home can be a more deliberate process.

Table 4.4: Goodness of fit measures

	Chi-squared	df	p	NFI	NNFI
Null Model	333.16	78	0.000	-	-
Estimated Model	15.10	19	0.716	0.955	1.063

Those who found their job through the internet stayed the least amount of time at their residence when finding a new job. Since the trend for internet users persists even after controlling for age and distance, there may be unseen variables among those that use the internet to find jobs that makes them footloose and less attached to their residential location. Those who used contacts have the anticipated direction, but the magnitude is less than that for internet users, and statistically it is not significant. The estimate for newspaper users is as anticipated, but it too is not statistically significant.

These observed variables have direct and indirect impacts on the home-to-work distance after relocation (D) and how far away from their current home individuals relocate (D_{hh}).

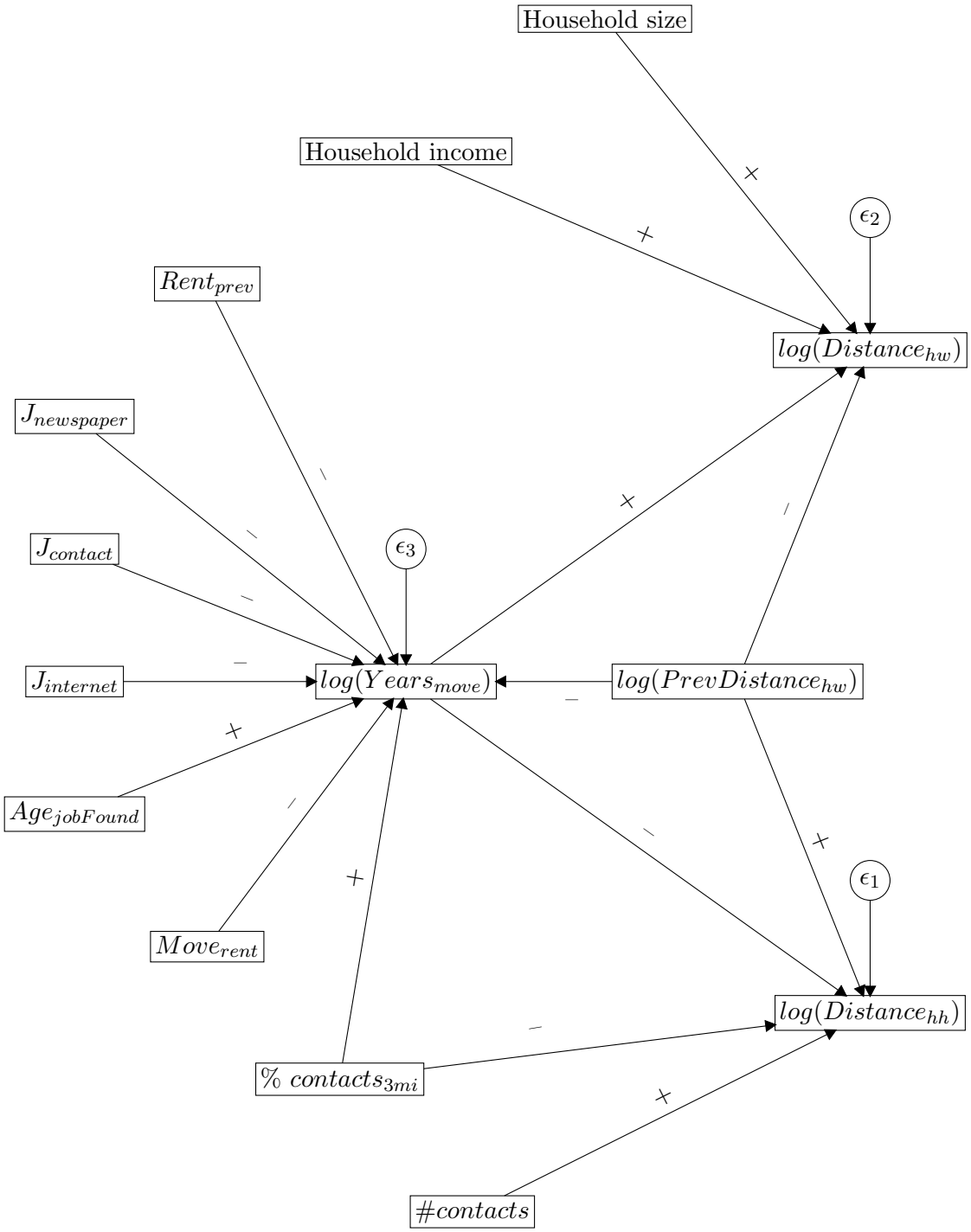


Figure 4.2: Proposed path model of tenure, commute, and moving distance after finding employment (correlations between exogenous variables not shown.)

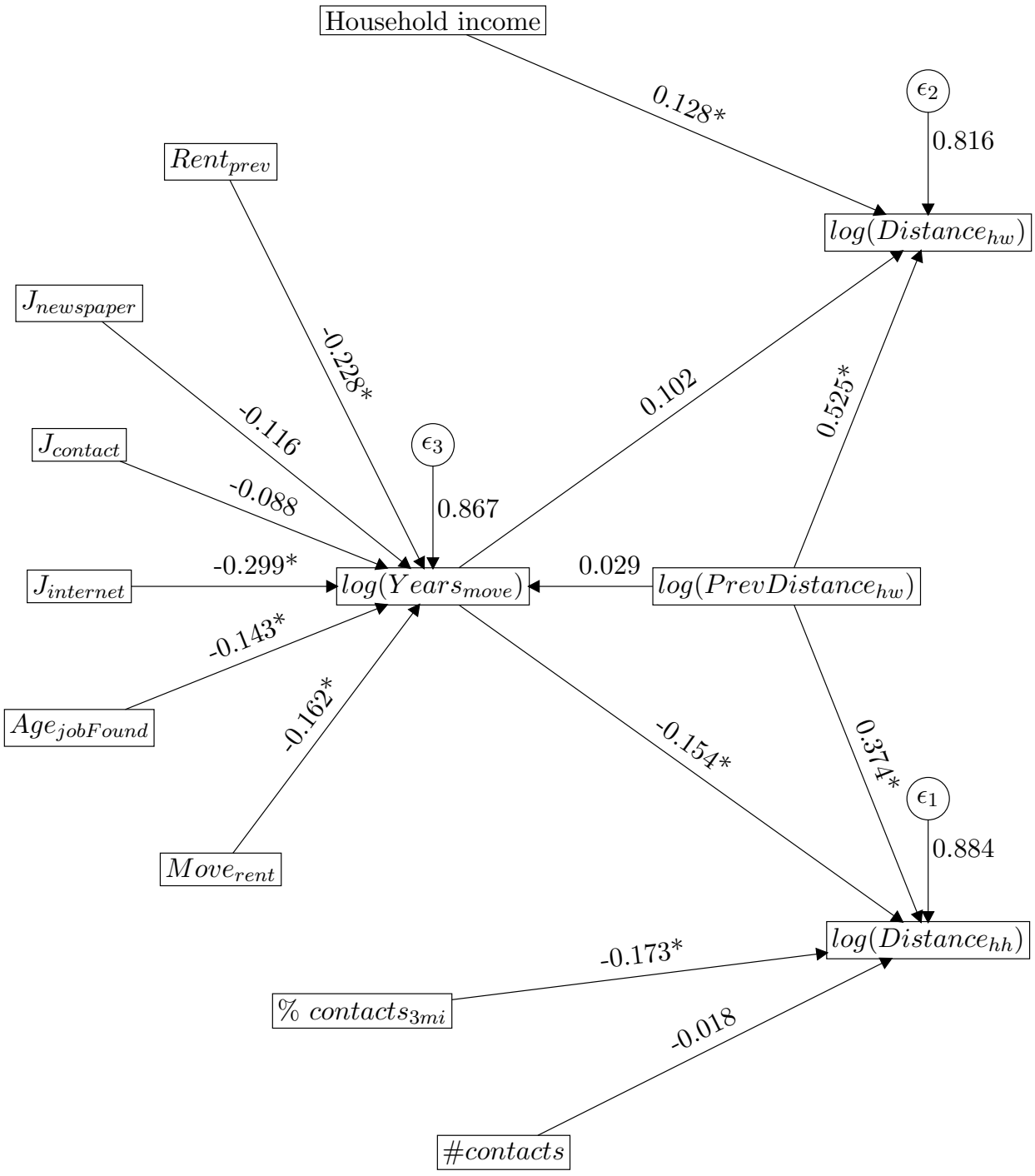


Figure 4.3: Estimated path model of tenure, commute, and moving distance after finding employment (correlations between dependent variables not shown. See Table 4.6). Estimates that are significant at the .05 level are marked with a *.)

Table 4.5: Estimated path model for relocation after finding work

		Variable	Estimate	Std. Error	t-stat
Time between finding work and relocation ($log(Y_{mv})$)	Distance before move	$log(D_p)$	0.030	0.070	0.43
	Job through contact	J_c	-0.155	0.135	-1.14
	Job through internet	J_i	-0.875	0.198	-4.41
	Job through newspaper	J_n	0.278	0.180	1.55
	Age job taken	A_j	-0.020	0.010	-2.06
	Moving to rental?	R_c	-0.317	0.149	-2.13
	Rented before move?	R_p	-0.444	0.142	-3.12
	Error variance		0.555		
	Total variance		0.740		
	R^2		0.249		
Commute distance after move ($log(D)$)	Years to move	$log(Y_{mv})$	0.103	0.064	1.59
	Distance before move	$log(D_p)$	0.541	0.066	8.17
	Household income (1000)	I	0.027	0.014	1.97
	Error variance		0.499		
	Total variance		0.750		
	R^2		0.335		
Previous to new home distance ($log(D_{hh})$)	Years to move	$log(Y_{mv})$	-0.164	0.073	-2.24
	Distance before move	$log(D_p)$	0.406	0.076	5.32
	Num. of contacts (/10)	C	-0.009	0.036	-0.26
	% of contacts in 3mi	C_{p3}	-0.009	0.004	-2.46
	Error variance		0.655		
	Total variance		0.837		
	R^2		0.218		

The home-to-work distance after relocation depends weakly on how soon the relocation occurred, but is strongly related to what the commute distance before relocation was, and with household income. Each percentage increase in 'previous home-to-work distance' are is positively related to the new home-work-distance. It suggests that those who had tolerated longer commutes before, will tolerate them still after a move.

Though not statistically significant, the model also suggests that those who experienced the previous home-to-work distance for a longer period of time after finding their work also had longer commutes. This is consistent with the idea that those who do not relocate quickly relocate for reasons other than commute. A household's income also plays a role in the home-to-work relocation after a move. With each $1,000 increase in household income, the new home-to-work distance increases by 2.7%. This is consistent with our hypothesis that wealthier households might be concerned about other aspects that are not commute related. No direct relationship was found between being household size and home-to-work distance.

Table 4.6: Correlations among exogenous variables for relocation after finding work (only those above 0.1 reported)

Variable 1	Variable 2	Correlation
A_j	C	0.159
A_j	C_{p3}	0.126
A_j	R_p	-0.215
R_c	R_p	0.258
I	R_c	-0.285
I	R_p	-0.253
J_c	I	0.107
J_c	C_{p3}	0.138
J_c	R_p	-0.122
J_i	A_j	-0.178
J_i	R_c	0.277
J_i	I	-0.141
J_i	R_p	0.173
$log(D_p)$	I	0.184
$log(D_p)$	J_i	0.109
$log(D_p)$	C	-0.112
$log(D_p)$	C_{p3}	-0.192
C	R_c	-0.169
C	R_p	-0.131
C_{p3}	R_c	-0.141
C_{p3}	R_p	-0.169

In choosing the new neighborhood, another factor that is considered is how far away the person moves from their previous neighborhood. The D_{hh} variable measures this distance. As hypothesized earlier, an important consideration for how far people moved from their previous location is assumed to be neighborhood quality as well as the contacts that they would leave behind. The model shows that those that didn't relocate as quickly did not relocate farther. For each additional year stayed at the home before relocation, the previous home to new home distance reduces by 1.6%.

Another important variable that indicates how far a person moves is the percentage of contacts that live around them. Here the role of contacts is clear. The model suggests that the for each percentage gain in the proportion of close contacts in a 3 mile radius, the relocation distance from their previous home is reduced by 0.9%. The significance of the relationship supports the hypothesis that the people who have a larger proportion of their contacts close by stayed close to those contacts when moving.

Table 4.7: Overall and indirect effects of exogenous variables on relocation, commute and tenure

	Overall effect			Indirect effect	
	$log(D)$	$log(D_{hh})$	$log(Y_{mv})$	$log(D)$	$log(D_{hh})$
$log(D_p)$	0.544	0.401	0.030	0.003	-0.005
J_c	-0.016	0.025	-0.155	-0.016	0.025
J_i	-0.081	0.13	-0.792	-0.081	0.130
J_n	0.029	-0.046	0.278	0.029	-0.046
A_j	-0.002	0.003	-0.020	-0.002	0.003
I	0.027	0	0	0	0
C	0	-0.009	0	0	0
C_{p3}	0	-0.009	0	0	0
R_c	-0.034	0.054	-0.329	-0.034	0.054
R_p	-0.046	0.073	-0.448	-0.046	0.073
$log(Y_{mv})$	0.102	-0.164	0	0	0

4.5 Summary

This chapter looked at commuting outcomes of job finding, and the commuting outcomes of relocations. One of the hypothesis that was tested is that job search methods can impact the commute distance because of the ways in which information is gathered. Specifically it was hypothesized that jobs found through internet searches would be on average farther out than traditional methods. The findings from the first part of this chapter support this hypothesis. In addition it was also found that commute distances from newspaper found jobs were also longer than jobs found through formal means or contacts.

The relationship between job search, tenure, relocation, and social networks was also studied using path analysis. The findings suggest that relocation costs (renting before, and moving to a rental) were instrumental in how quickly individuals relocated after finding their work. Job searchers who used the internet to find their current employment also relocated faster reinforcing the hypothesis from the first section of the analysis.

Though contact found jobs did not show particular patterns in regards to tenure, other social network variables were found important in the relocation choice. The percentage of contacts that are within a 3 mile radius of a person (self reported) has a negative relationship with how far away one relocates. This suggests that social networks have an influence location decisions. This role, though essential from the decision makers perspective, may limit the reductions in commute that may be achieved through relocation.

Chapter 5

Social Meeting Location Decisions

5.1 Introduction

Social activity travel is an important part of a household's total travel. According to the 2001 National Household Travel Survey, on average social and recreational travel accounts for 24.5% of a household's annual distance travelled (55). Continuing on the theme of social networks from the preceding chapters, this chapter explores the more direct travel related role that social contacts play in the selection of meeting locations.

Social meeting travel has much less structure than travel to work. Its frequency can vary significantly from person to person or even for the same person from week to week. It is dictated not only by the schedule of the traveller of interest but also by who else is involved in the meeting. Meeting location can vary from day to day, as can the time at which the meeting takes place. In fact, any structure that exists in social activity travel may come from the fixedness of working hours, employment locations, household constraints of the meeting parties and the operating hours of the meeting locations (when meetings occur outside the home) and the physical limitations that Hagerstrand (6) discusses.

Advances in communication technologies add an interesting dimension to this complexity. Due to the instant access one has to an increasing number of contacts at all times of the day through mobile phones and other technologies, meetings can now be scheduled and rescheduled on short notice. Lower technological costs also mean more frequent interaction through these other means and that may lower the need for face-to-face meetings. Expanding communication possibilities also exist with higher bandwidth and the expanded use of video communications via computers.

While these technologies may alter how, when and with what frequency we interact, we are not yet at a point where face-to-face engagement is about to become a thing of the past. Spending "face time" with someone implies sharing the the totality of the environment at that moment. Such interaction often takes longer, and is relaxed in the sense that there

isn't a need for constant back and forth over the course of the meeting. Widely available technologies do not afford such an experience; first because, the parties are in two different environments, and second because they require either constant engagement over the duration of the communication (as in a phone conversation) or are asynchronous (as in email). In both cases, albeit to varying degrees, there is little chance of a shared experience in the moment that leads to new and sustained conversation as would happen in face-to-face meetings.

5.2 What Gives Social Meetings Structure?

For workers, one can posit that a significant amount of structure to the times, duration and location of meeting is imposed by the locations of home and work, and the time constraints placed by employment and household responsibilities. Countering these effects is the role played by technological advances from faster transportation modes to communication technologies that enable scheduling of meetings as time slots open, as well as transportation cost reductions and car ownership that enable traversing of long distances in short amounts of time.

The availability of a wide range of communication technologies has possibly cut down on meetings that otherwise would have required face-to-face interactions, or removed the temporal constraints that phone conversations place on the parties involved. Access to the internet and email enable conversations to occur without constraining the parties involved to participate in the back and forth in real time. On the other hand, with expanded use of mobile phones and the "instant" access it affords to contacts, scheduling/rescheduling is made much easier. One can easily call on a friend when in their neighborhood today than it was perhaps possible two decades ago because more people can be readily reached. In the past contacts would have to be sought at their home or work place in advance where they had land lines to be reached.

One can think of positive and negative constraints on face-to-face social interactions. Work schedules, family responsibilities, sleep and rest requirements tell us when these meetings are unlikely to occur. On the other hand, these constraints are weakened by the ability to free up time by using passive technologies to interact with many others, and by the additional ability to organize meetings on very short notice. The ability to telecommute and having a flexible work schedule also loosen these constraints.

The availability of multiple modes of communication at different costs allows users to pick and choose how they meet with different contacts. Here the type of relationship that one has with the contact influences meeting decisions such as where one meets (at home/out-of-home) and creates tradeoffs on how far one is willing to travel for a face-to-face meeting.

In the following sections data collected to study the interdependence of personal characteristics, type of relationship, meeting purpose and meeting location is described. That will be followed by an analysis of meeting locations in-home or out-of-home. Finally out-of-home

meetings are studied by considering the dependence between relationship type, meeting duration, and home to meeting distance along with other demographic variables.

5.3 Data Summary

The data for this portion of the study comes from the survey described in chapter 3. This section summarizes the data on meeting location, duration, purpose, relationship of the person that meetings took place with, and so on. In addition it examines how respondents use different communication media to maintain their relationships as well as schedule their meetings. The next section investigates the interrelationships among these variables and personal characteristics.

The analysis is limited to meetings that are local (happened within the metropolitan area). A one week meeting diary based on recall was collected from the participants of phase 2. Respondents were asked to "list all scheduled meetings you had in the last 7 days outside of your work location" and to include "all meetings with family, friends, get togethers, parties, civic engagements, meetings for personal/home related tasks, first time meetings, etc." There were 744 meetings from 222 respondents that took place within the metropolitan area.

Just over a third of these meetings (33.9%) occurred in-home, either at the respondent's residence or their contact's residence. The proportion of meetings that occur inside a home on weekdays is smaller than on weekends. Of 737 meetings for which location and date is known, in-home meetings make up 26.3% of weekday meetings, and 44.1% of weekend meetings. Weekday meetings are significantly more likely to be out-of-home than weekend meetings. During the weekend, 65% of meetings reported by single females were out-of-home, while 50% of meetings reported by single men were out-of-home. For multi-person households the figures are 45.9% for men and 46.9% for women. For weekday meetings on the other hand, 83.3% of meetings for single men occur out-of-home, 79.1% for single women, and 70.5% and 72.5% for men and women of multi-person households respectively.

Table 5.1 shows the average and median home to meeting distances on weekends on weekdays respectively. The first two columns and the last column only look at out-of-home meetings only. In general meetings tended to be closer to home than to work. When meetings take place at family/friends' homes on weekends, both the average and median distances were longer than the other categories. Meeting locations with family and friends, when they occur out-of-home, are similar to the overall weekday and weekend averages.

Meeting locations including the in-home meetings from the one week diary are shown in 5.1. Over the period of seven consecutive days, many people had more than one meeting. The distribution of number of meetings per person is given in figure 5.2. The sudden drop from the number of people that had six meetings to those that had seven meetings might in part have been affected by the survey layout. Because responses for the seventh entry and on were on a second page, some of the respondents may have found it too demanding to fill out.

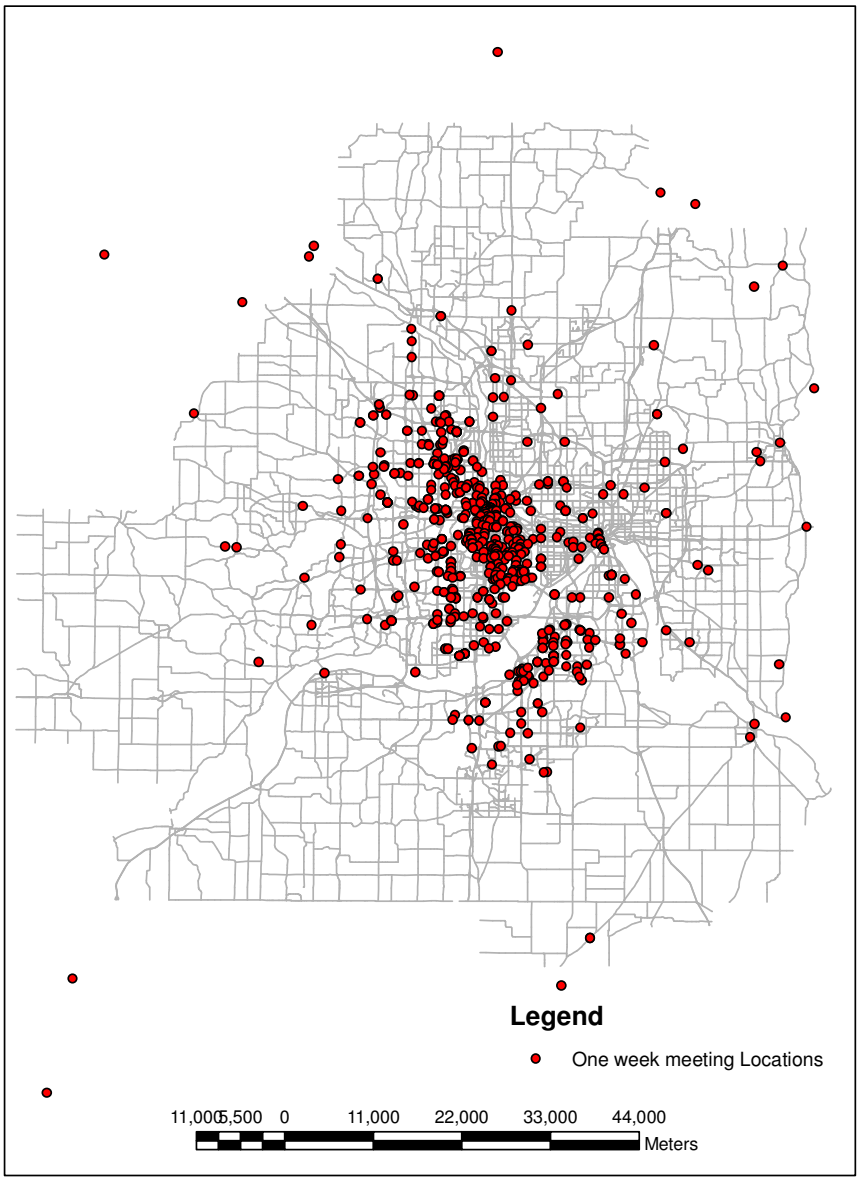


Figure 5.1: Respondents meeting locations

Table 5.1: Distances for out-of-home meetings (mile)

Distance: (mean/median)	home to meeting	work to meeting	home to friend's or family home	home to meeting (family/friend only)
Weekday	7.26/6.13	9.5/7.93	8.68/7.32	7.20/5.89
N	349	334	161	44
Weekend	7.59/6.34	9.98/9.26	13.25/12.03	8.52/7.0
N	144	138	78	46

This may mean that the analysis here underestimates the number of meetings that people make and that it may not capture the full geographic scale of the meeting locations. Despite this problem, we still have a large amount of information to analyze the location of meetings relative to the respondent's home and work.

About half of the out-of-home meetings reported in the one week period are with close friends (30.3%) and family (18.1%). These two groups also constitute 58.3% of all meetings (including in-home meetings). The rest are divided between business coworkers and other contacts as shown in table 5.2. Meetings that involve more than one person constituted 6.2% of all out-of-home meetings.

Table 5.2: Proportion of meetings by contact relationship

Contact type	Percentage of all meetings	Percentage of out-of-home meetings
Close friend	33.21	30.32
Family	25.12	18.07
Coworker	7.48	10.04
Business contact	6.25	8.63
Church Contact	6.00	8.23
Social club contact (book clubs etc.)	4.90	5.22
Distant Friend	3.06	3.61
Neighbor	3.19	1.81
More than one person	4.90	6.22
Other	5.39	7.43
Unreported	0.49	0.40
	100%	100%

5.4 In-home and Out-of-home Meetings

Decisions on where to have a meeting depend on a variety of factors that have to do with the person's characteristics, circumstances of the meeting and the location of opportunities

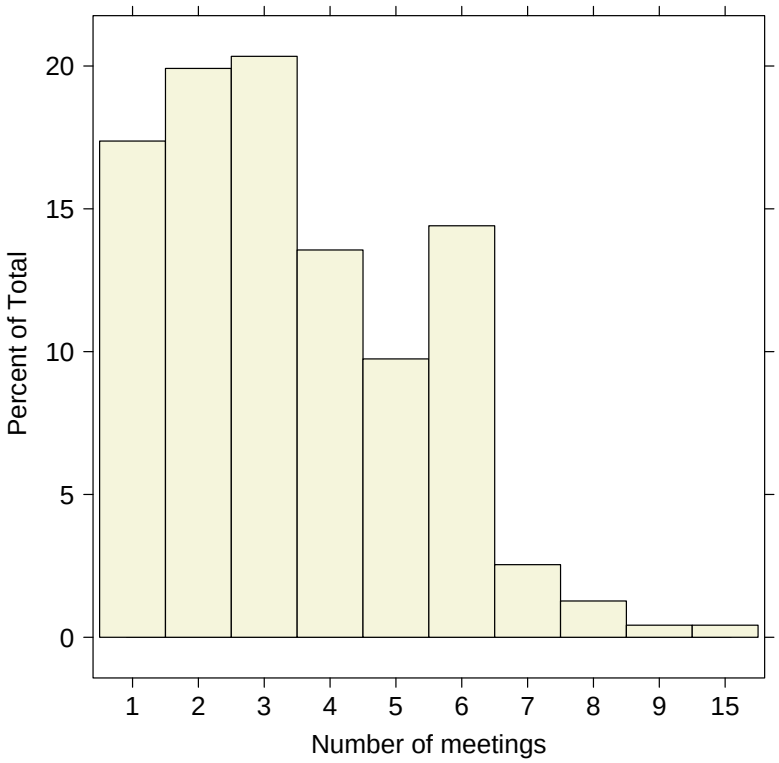


Figure 5.2: Number of meetings for respondents on the week prior to taking the survey

around them. In this section we will first investigate what motivates the in-home/out-of home decision for a meeting. It is assumed that in-home meetings are fundamentally different from even those meetings occurring very close to home. In-home meetings are generally with people one feels a stronger affinity to. A person may be comfortable inviting a contact to a neighborhood coffee shop but not necessarily into their homes.

In addition to the nature of the relationship between the meeting parties, whether a meeting occurs at home may be motivated by the purpose and anticipated duration of the meeting. It is expected that meetings at home would have longer durations. In addition, it is also expected that at leisure meetings are more likely to occur at home than other types of meetings.

Individuals that have more of their contacts close to their home are expected to have in home meetings more often than individuals with fewer friends close by. Household characteristics are also expected to be important. Larger households are expected to have more meetings at home than smaller ones.

A binomial logit model that predicts out-of-home meetings as a function of the personal characteristics and the meeting variables is specified as follows:

$$L \sim f(C_r, M, T_{mt}, F, Y_h, W, C_{p3}, S, H)$$

where

L: Location of meeting (1= out-of-home, 0=in-home)

C_r: The nature of the relationship (close contact vs. distant contact). Close relationships are those identified as family and close friend. (distant=1)

M: Meeting purpose (1=leisure, 0=otherwise)

T_{mt}: Meeting duration (in 10 minute increments)

F: Does the person telecommute? (1=yes)

Y_h: Tenure at home (years)

W: Weekend (yes=1)

C_{p3}: Proportion of contacts in 3 miles of respondent's home

S: Sex (male=1)

E: Education (0=high school graduates, 1=above High school)

H: Household size (1=single, 0=otherwise)

The estimated model is given in table 5.3. The model captures the overall tendency to have meetings out of home rather than in-home in the intercept term. The nature of the relationship with whom the respondent is meeting has a significant influence on the location

of the meeting. Meetings with close contacts were less likely to occur out of home as compared to meetings with less closer contacts. In the data about 58% of meetings were with close contacts - close friends, and family. Overwhelmingly close contacts tend to be met at home (or at their home). Seventy five percent of in-home meetings were with family or close friends. out-of-home meetings on the other hand are divided 48% to 53% as being with close and distant contacts respectively.

Table 5.3: Binomial logit model of in-home/out-of-home meeting choice (1=out-of-home, 0=in-home)

		Estimate	Std. Error	z value	Pr(>|z|)
(Intercept)		1.547	0.416	3.72	0.000***
Close relationship	C_r	-0.553	0.219	-2.53	0.011*
Meeting purpose	M	-0.785	0.246	-3.19	0.001**
Meeting duration	T_{mt}	-0.092	0.059	-1.56	0.118
Telecommute?	F	0.515	0.217	2.37	0.018*
Home tenure	Y_h	0.029	0.013	2.22	0.027*
Weekend	W	-0.673	0.191	-3.52	0.000***
% contacts in 3mi	C_{p3}	0.670	0.529	1.27	0.205
Sex	S	0.160	0.208	0.77	0.442
Education	E	0.688	0.255	2.70	0.007**
Household size	H	-0.196	0.070	-2.81	0.005**
Null deviance		797.11	df=644		
Residual deviance		697.15	df=634		
Psuedo-R^2		0.125			
sig	$***<0.001$	$**<0.01$	$*<0.05$	$.<0.1$	

Table 5.4: Predictive accuracy of in-home/out-of-home meeting model

	Predicted probabilities	
	$< .5$	$\geq .5$
In-home	59	140
Out-of-home	45	401

The meeting purpose is also closely associated with the meeting purpose. Compared to the base category of non-leisure meetings, leisure meetings were less likely to be outside of the home. Business or other purpose meeting tended to occur out side of the home.

It is assumed that people have a general idea of how long a meeting would take and would make location decisions accordingly. The findings weakly suggest that longer meetings take place at home (p-val=0.118). But as will be shown later, when considering out-of-home meetings separately, longer meeting durations are also associated with longer meeting distances. The tendency for longer duration of in-home meetings can also be explained by

the fact that many of these are leisure meetings with close contacts, and are therefore less formal.

Approximately 31% of the respondents indicated they occasionally telecommute to work suggesting some level of flexibility on their work schedule. On average these individuals tend to have meetings outside of the home as compared to their counterparts that responded they don't telecommute. Tenure at home is also significantly associated with in-home meetings.

The model also illustrates that weekend meetings as well as meetings of people with larger households tend to happen in-home relative to weekday meetings and the meetings of single households respectively. Finally those with college level education tend to have more meetings out of home relative to those with high school level education.

The C_{p3} variable, which measures the proportion of contacts that live in 3 miles of the respondent's residence is not statistically significant in predicting meeting location (p-val=0.205). Sex is also found not to matter in deciding whether a meeting is in-home or out-of-home.

Overall the model categorizes 71.3% of the observations as happening in-home or out-of-home correctly (Table 5.4). However, it falsely predicts in-home meetings as being out-of-home in many instances. The model also suffers because information on the parties being met, whom one can assume had as much contribution as the individuals being considered here, is lacking.

5.5 Out-of-home Meetings

For this part of the study we shall focus on meetings that occur outside of the respondent's or their contact's residence. It is hypothesized that the choice of out-of-home locations depends on the individual and their household constraints, as well as on who they are meeting including the nature of the relationship. Expectations on the duration of the meeting, and the availability of possible meeting locations in the neighborhood in which the individual lives is also expected to influence the meeting location. The interdependence of many of these variables on each other (e.g. personal variables on duration and distance, distance on duration, etc.) call for an integrated model where the structure of the data and the interdependence can be studied.

Duration and distance decisions are likely to be interrelated. For scheduled meetings, it is hypothesized that individuals would be willing to travel longer distances for longer duration meetings. Since meetings would revolve around some purpose whose duration one is likely to anticipate before hand, the meeting location decision is likely to be affected by it. The decision would try to balance duration and distance, as well as balance duration with other household and individual constraints. Weekend meetings for example are likely to be longer, just because work constraints on time are not present. Larger household sizes are likely to

lead to shorter durations because of other household responsibilities on the person's time allocation.

A path model is proposed where the effects of different variables and their covariance is modeled explicitly. Figure 5.3 presents the proposed model. Meeting duration is proposed to depend on age, education, household size, income, relationship and meeting purpose, while the home to meeting distance is proposed to depend on the relative quality of the respondent's home neighborhood in terms of available meeting destinations, the availability of vehicles, the flexibility of their schedules as well as demographic characteristics of the respondent.

The relative availability of destinations is measured as the ratio of the proportion of entertainment, food, and retail businesses in the residential blockgroup of the respondent, to the aggregate proportion of such businesses businesses in the metropolitan area. This number is less than 1 if the blockgroup has a lower proportion of these businesses, which can serve as meeting locations, relative to the metropolitan area. This is similar to how location quotients are calculated in economic base modeling. Here the number of businesses in a particular sector are used to calculate the quotient. Values greater than one indicate that relative to the metropolitan area the residence blockgroup of the respondent has a higher share of businesses that are focused on retail, food and entertainment.

The variables included in the final path model are:

L: Location of meeting (1= out-of-home, 0=in-home)

D_{mt}: The home to meeting location distance.

T_{mt}: Meeting duration (in 10 minute increments)

C_r: The nature of the relationship (close contact vs. distant contact). Close relationships are those identified as family and close friend. (distant=1)

F: Does the person telecommute? (1=yes)

W: Weekend (yes=1)

H: Household size (1=single, 0 otherwise)

A: Age of the respondent

V: Number of household vehicles

Q: Neighborhood quotient, measuring if the respondent's block group has a higher proportion of food, entertainment, and retail businesses as compared to the metropolitan area as a whole.

Model fitting is done using the SAS/CALIS software (54). The goodness of fit measures for the model are given in table 5.5. The estimated path coefficients and correlations are summarized in tables 5.6 and 5.7. The chi-squared measure in table 5.5 compares the

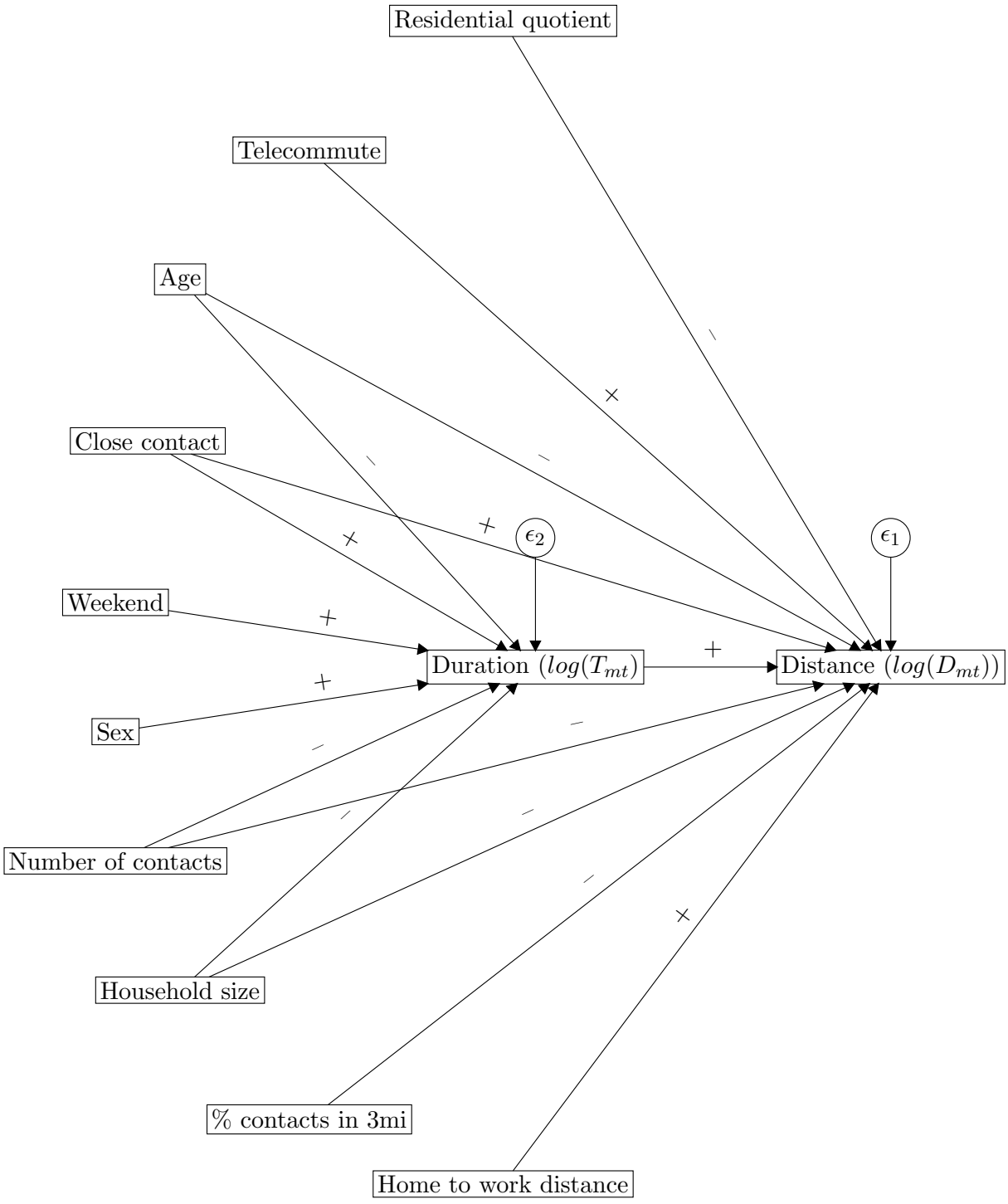


Figure 5.3: A path model of meeting distances and meeting duration for out-of-home meetings(correlations between trip variables are not shown)

covariance matrix from the estimated model with the observed model. A large p-value is evidence that the estimated covariance closely resembles the observed relationships in the model (failure to find a statistical difference). None of the adjusted residuals exceeded a value of 1.2 in absolute value. Values of 0.9 and above in the NFI and NNFI indices indicate that the model provides an acceptable fit. Table 5.8 summarizes the overall and indirect effects of the exogenous variables in our model on meeting duration and home to meeting distance. Figure 5.4 shows the relationships between the variables using standardized path coefficients (i.e. these are similar to the coefficients that would be estimated if all variables in the model were standardized so that they have mean 0 and variance of 1).

Based on the analysis, the proposed model has been readjusted to reflect the best fit. For instance the link between age and meeting duration, number of contacts and distance as well as percentage of contacts in 3 miles and duration has been removed from the proposed model (figure 5.3). The R^2 values for the duration and meeting distance indicate the amount of variance in that is accounted for by the direct paths. The models suggest that even though the impact of the variables included suggests clear trends, there is still significant variance left in the model to address. But this is expected to some degree as meeting decisions are also affected by the meeting parties that are not included in this analysis, and can also easily be influenced by variables such as the "mood" of the person on that particular day etc. that are difficult to capture based on observed variables.

The path model suggests that age has a negative influence on distance. The older one is the less they travel to meet others. While not statistically significant, telecommuters tend to travel farther for meetings, and those that have a relatively higher concentration of retail and entertainment businesses with in their residential blockgroup tend to travel less for meetings. This is likely because of the ample number of destinations that can be used as out-of-home meeting locations. People who have a larger percentage of their close contacts within three miles of their home also have shorter home to meeting distances. Household size and home to work distance both impact meeting duration positively. A possible reason for why larger household size individuals have longer meeting distances could be that they have meetings just after work, or as they run other errands outside of the home. On meeting duration, larger household sizes tend to shorten meeting durations as expected.

Home to meeting distances also increase with home to work distances positively. For each 10% increase in-home to meeting location, the home to meet distance increased by 1.3%. This suggests that the neighborhood around the work location is also an important meeting area. Coworkers make up 10% of out-of-home meetings and it is reasonable to expect at least many of the meetings with them and others are centered around the work location.

Table 5.5: Goodness of fit measures

	Chi-squared	df	p	NFI	NNFI
Null Model	244.43	66	0.000	-	-
Estimated Model	6.34	10	0.786	0.974	1.135

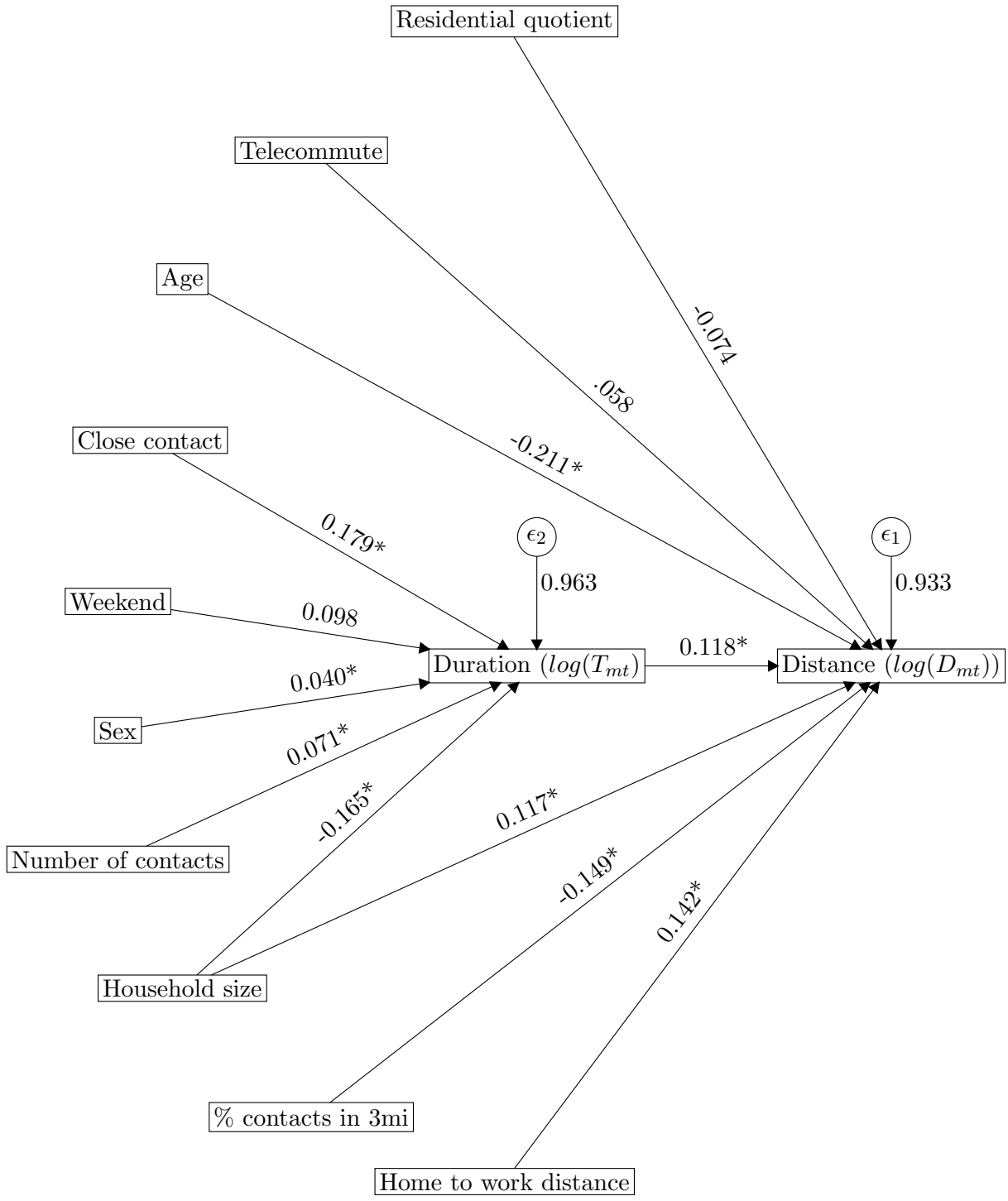


Figure 5.4: A path model of meeting distances and meeting duration for out-of-home meetings. Estimates are based on standardized data. See table 5.7 for correlation among independent variables.

Table 5.6: Estimated path model for meeting duration and home to meeting distance

		Variable	Estimate	Std. Error	t-stat
Home to meeting distance ($log(D_{mt})$)	Meeting duration	$log(T_{mt})$	0.114	0.049	2.341
	Home to work distance	$log(D_{hw})$	0.134	0.048	2.797
	Age	A	-0.014	0.003	-4.149
	Household size	H	0.072	0.03	2.442
	Telecomute (flexibility)	F	0.094	0.082	1.148
	Residence quotient	Q	-0.102	0.072	-1.407
	% of contacts in 3 mi	C_{p3}	-0.006	0.002	-2.795
	Error variance		0.541		
	Total variance		0.622		
	R^2		0.13		
Meeting duration $log(T_{mt})$	Close relationship	C_r	0.291	0.084	3.481
	Household size	H	-0.105	0.035	-3.036
	Weekend	W	0.174	0.091	1.906
	Number of contacts (/10)	C	0.037	0.028	1.311
	Sex (1=male)	S	0.072	0.03	2.442
	Error variance		0.613		
	Total variance		0.661		
	R^2		0.073		

Meeting duration on the other hand is significantly influenced by the type of relationship, the household size, gender and meeting day. Meetings with close relationships are expected to take about 34% longer all other things the same. Weekend meetings are also 19% longer, and men tended to have longer meetings than women by 7.4%. Larger household sizes have shorter meetings. The trend in the number of contacts suggests that larger social contact circle individuals tends to have longer meetings.

Longer durations are associated with higher distances travelled. A 10% increase in meeting duration, increases the distance one travels for the meeting by 1.1%.

The impact of duration on distances implies that the variables having a direct impact on duration have an indirect impact on distance. These effects are given in Table 5.8. The indirect impact of having close relationship with the contact, a weekend meeting and being male is positive. On the other hand household size has an indirect negative impact on distance through its impact on reducing meeting duration. Overall though its net effect of household size on distance is positive.

Table 5.7: Correlations among independent variables of the path model

Variable 1	Variable 2	Correlation
Q	C_{p3}	0.298
C_{p3}	S	-0.124
C_r	A	-0.153
$log(D_{hw})$	C_{p3}	-0.175
A	W	0.105
A	F	0.163
H	C	0.329
C_r	F	-0.103

Table 5.8: Total and indirect effects of model variables on meeting distance and duration

		Total Effects		Indirect Effects
		$log(D_{mt})$	$log(T_{mt})$	$log(D_{mt})$
$log(D_{hw})$	Home to work distance	0.134		
C_r	Close relationship	0.033	0.291	0.033
A	Age	-0.014		
H	Household size	0.06	-0.105	-0.012
W	Weekend	0.02	0.174	0.02
F	Telecomut	0.094		
Q	Residence quotient	-0.102		
C_s	Number of contacts (/10)	0.004	0.037	0.004
C_{p3}	% of contacts in 3 mi	-0.006		
S	Sex (1=male)	0.008	0.072	0.008
$log(T_{mt})$	Meeting duration	0.114		

5.6 Summary

In this chapter we have looked at how social meetings are scheduled, what determines whether the meetings take place at home or outside, and finally at what distances from each home the meetings take place. In general we find that the type of relationship, the meeting purpose and the individual's demographic background have some role to play. Mainly we have shown that in-home meetings tend to occur most often with close contacts and less often with distant contacts. The purpose, meeting day, and household size suggest that leisure, weekend and individuals with large household sizes tend to have their meetings either at their home or at their contact's home. On the other hand less known contacts are met outside of the home. When meetings take place outside of the home the duration was longer for close contacts, and longer durations translated into longer distance travelled. Gender as well as well as the number of contacts one has had a direct impact on the duration of meetings, and an indirect effect on the distance travelled. The more the number of contacts in close proximity to their homes, the less people travelled for their meetings and the farther out

their work locations, the longer their meeting locations from home. Overall this section has illustrated the importance of contacts and where they are located on the travel decisions for meetings.

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Appendix A

Recruitment Postcard

Figure A–1: Recruitment postcard

Appendix B

Web Survey

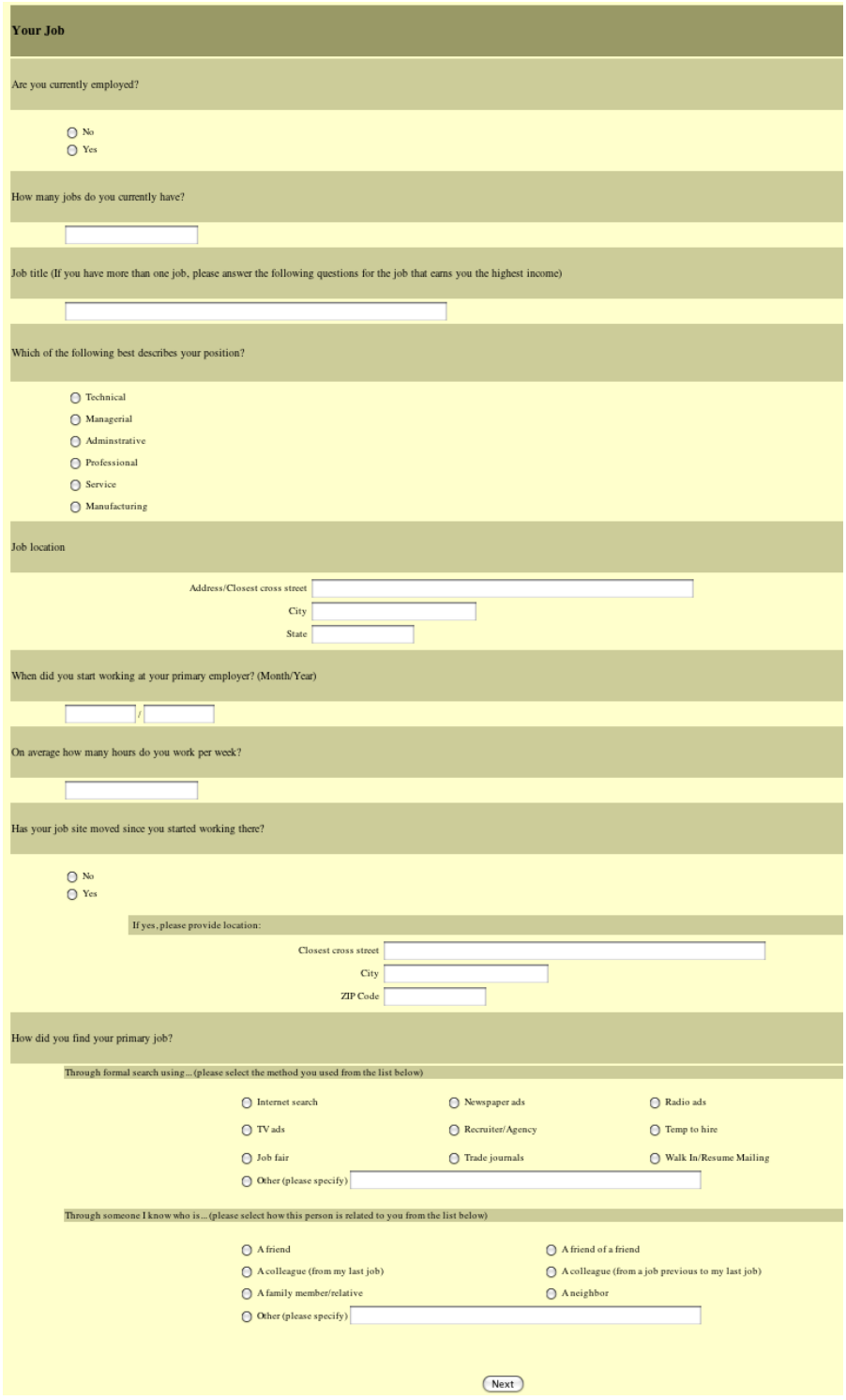


Figure B–1: Survey page 1

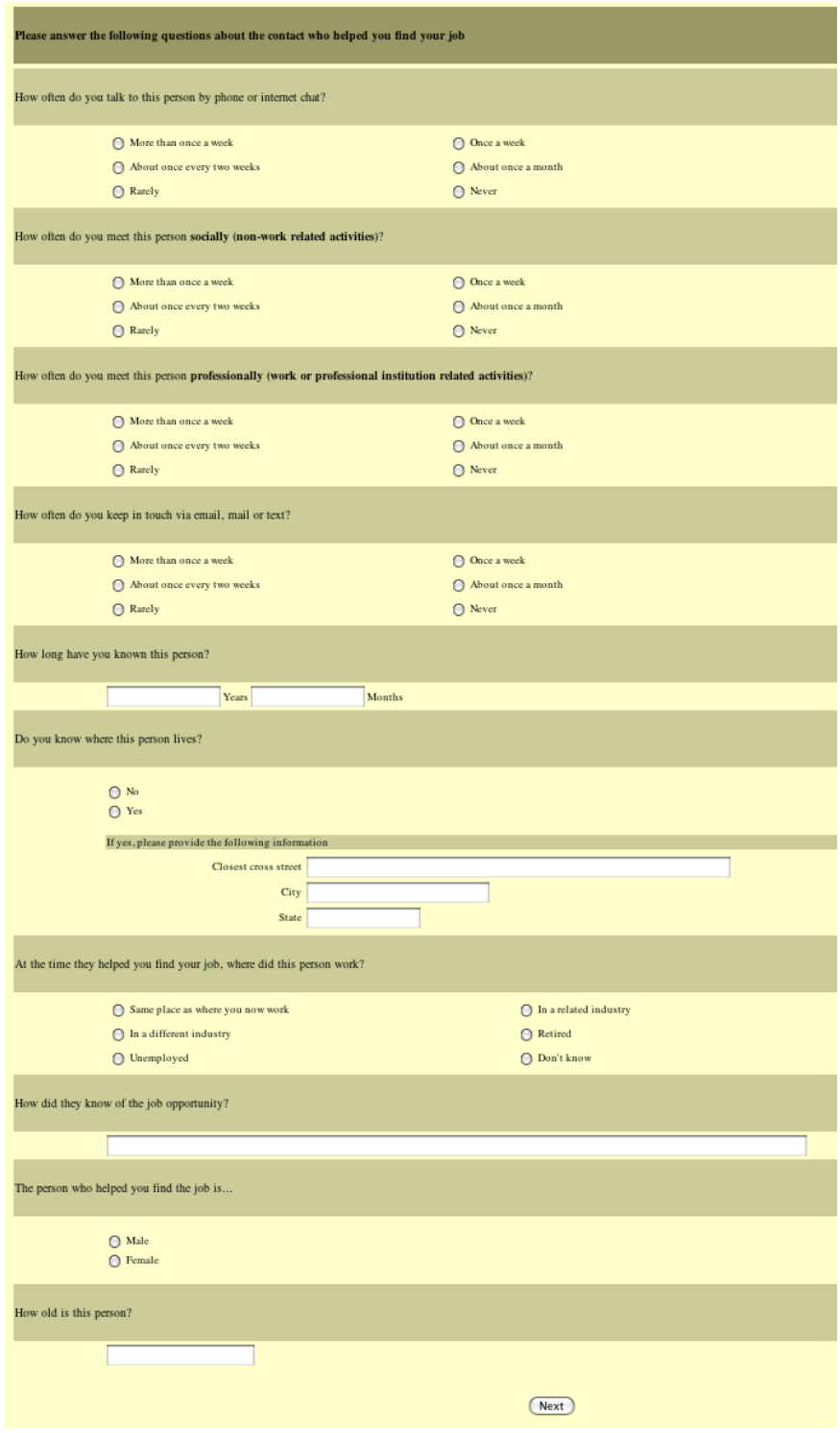


Figure B–2: Survey page 2

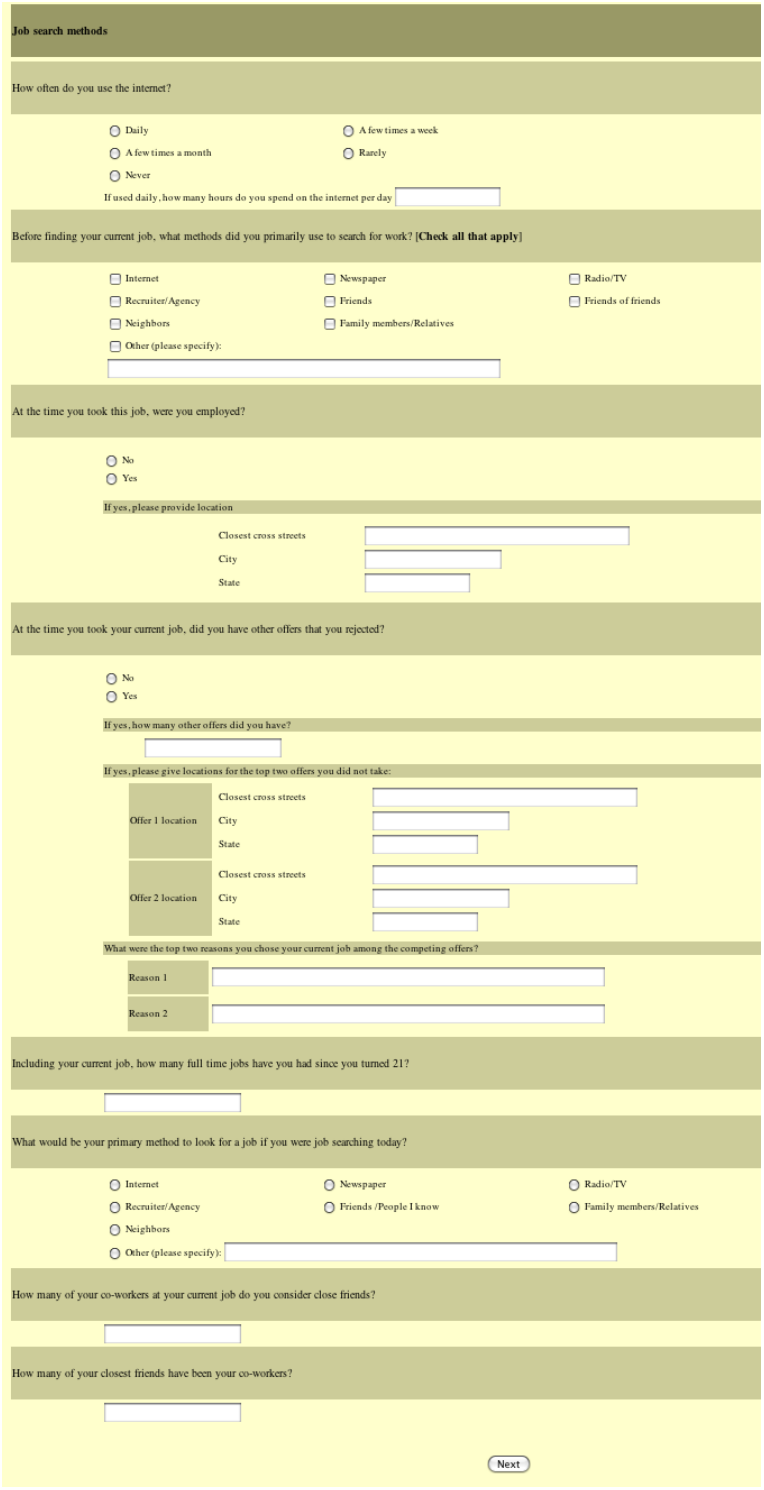


Figure B–3: Survey page 3

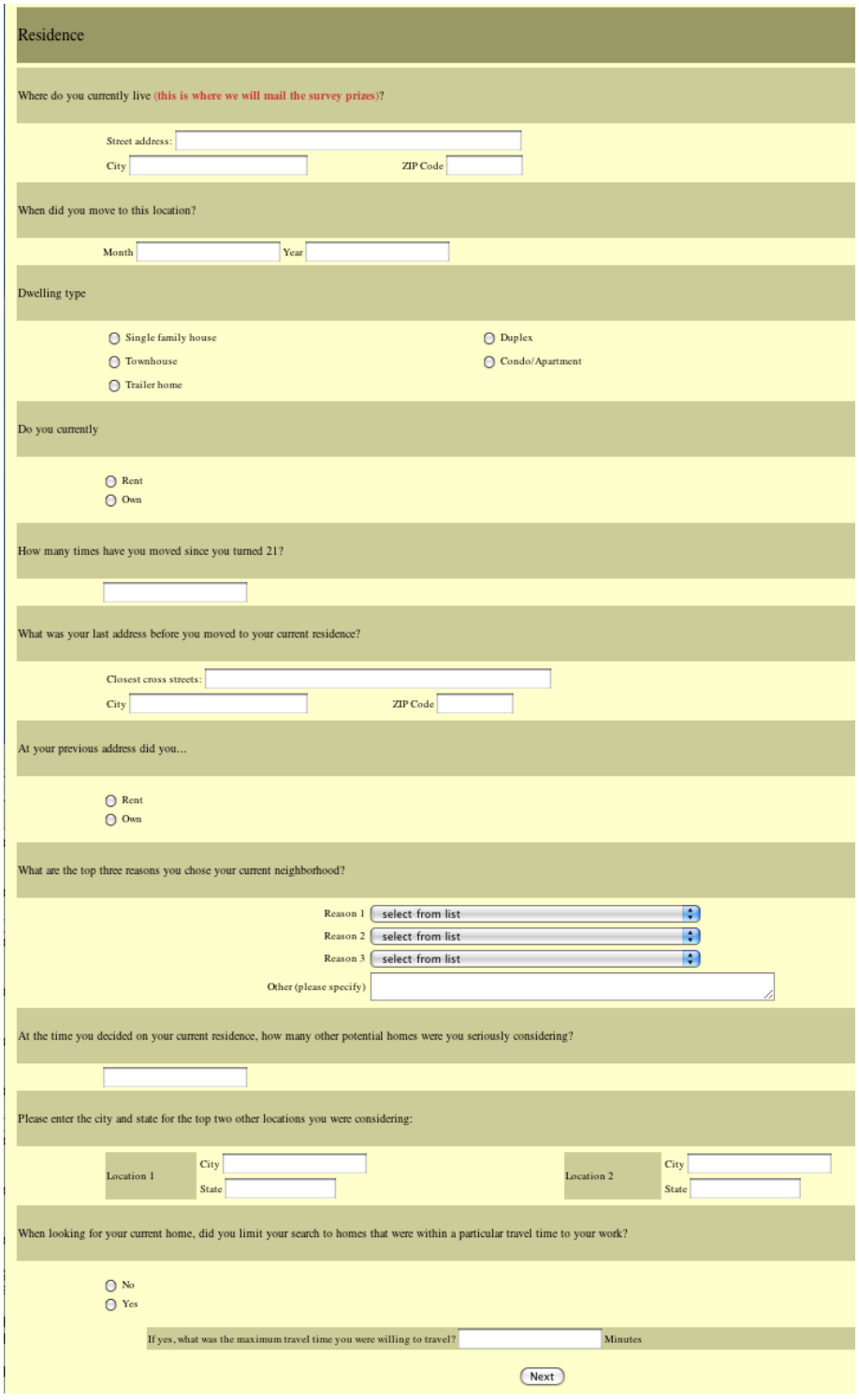


Figure B–4: Survey page 4

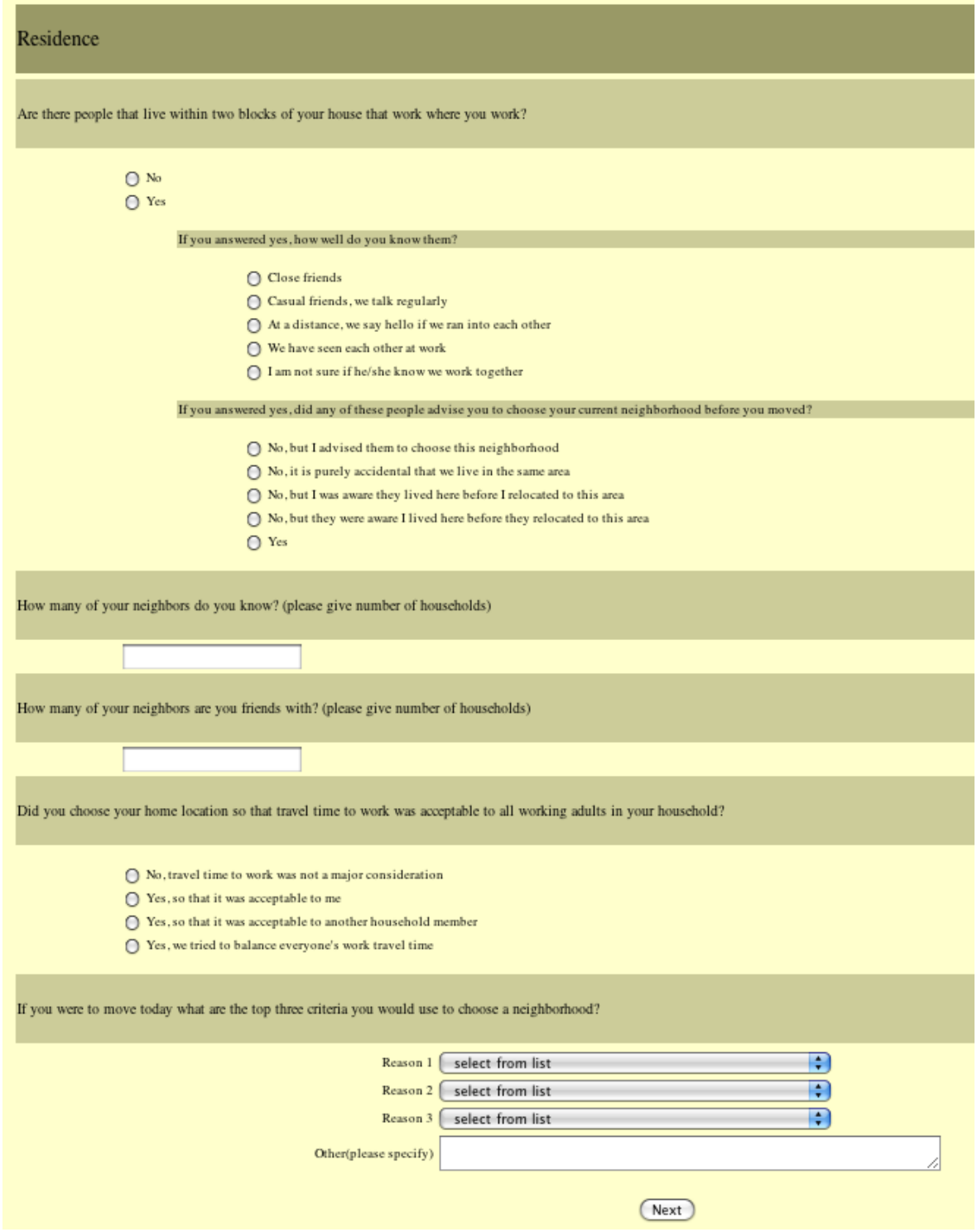
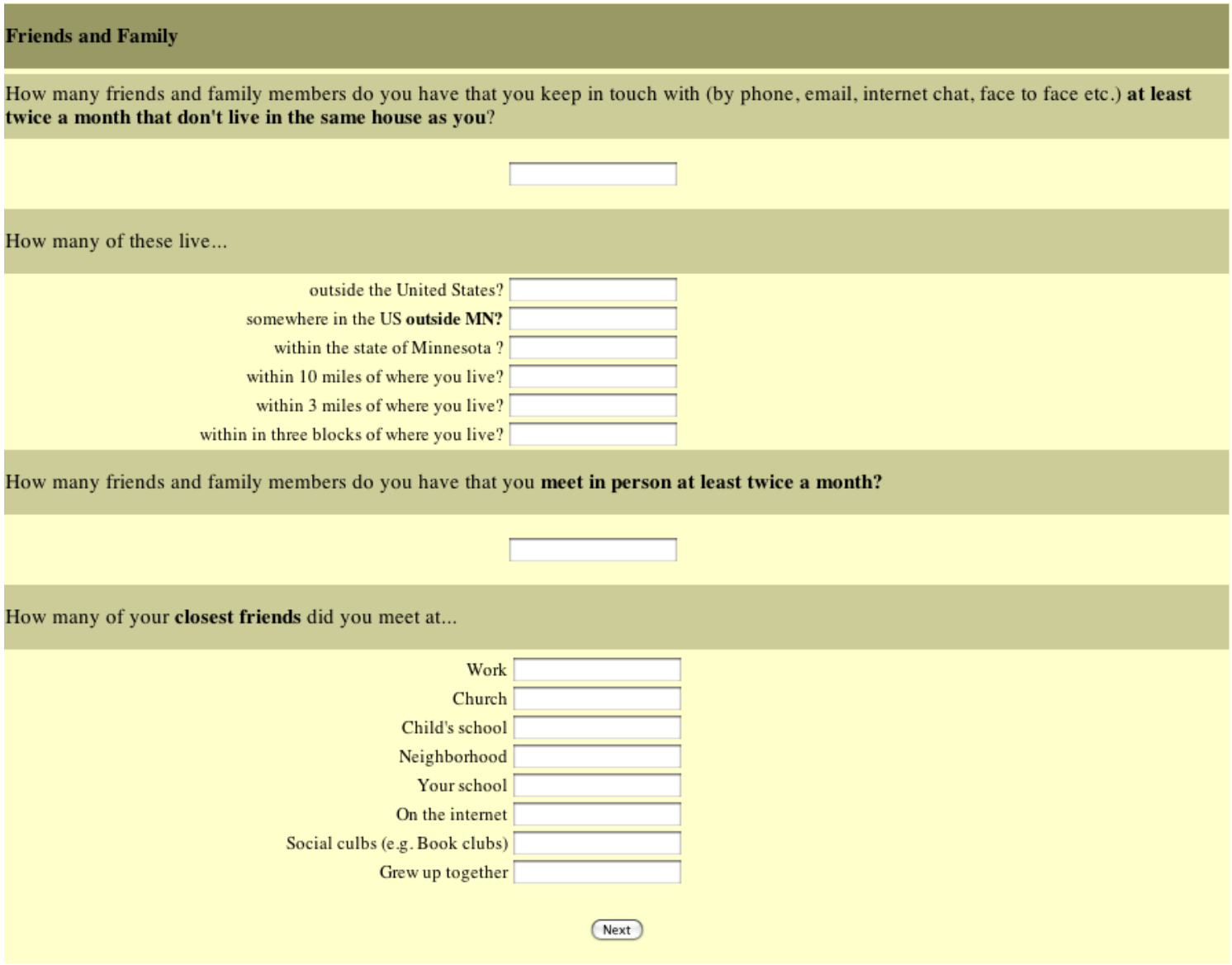


Figure B–5: Survey page 5



Friends and Family

How many friends and family members do you have that you keep in touch with (by phone, email, internet chat, face to face etc.) **at least twice a month that don't live in the same house as you**?

How many of these live...

outside the United States?
somewhere in the US **outside MN?**
within the state of Minnesota ?
within 10 miles of where you live?
within 3 miles of where you live?
within in three blocks of where you live?

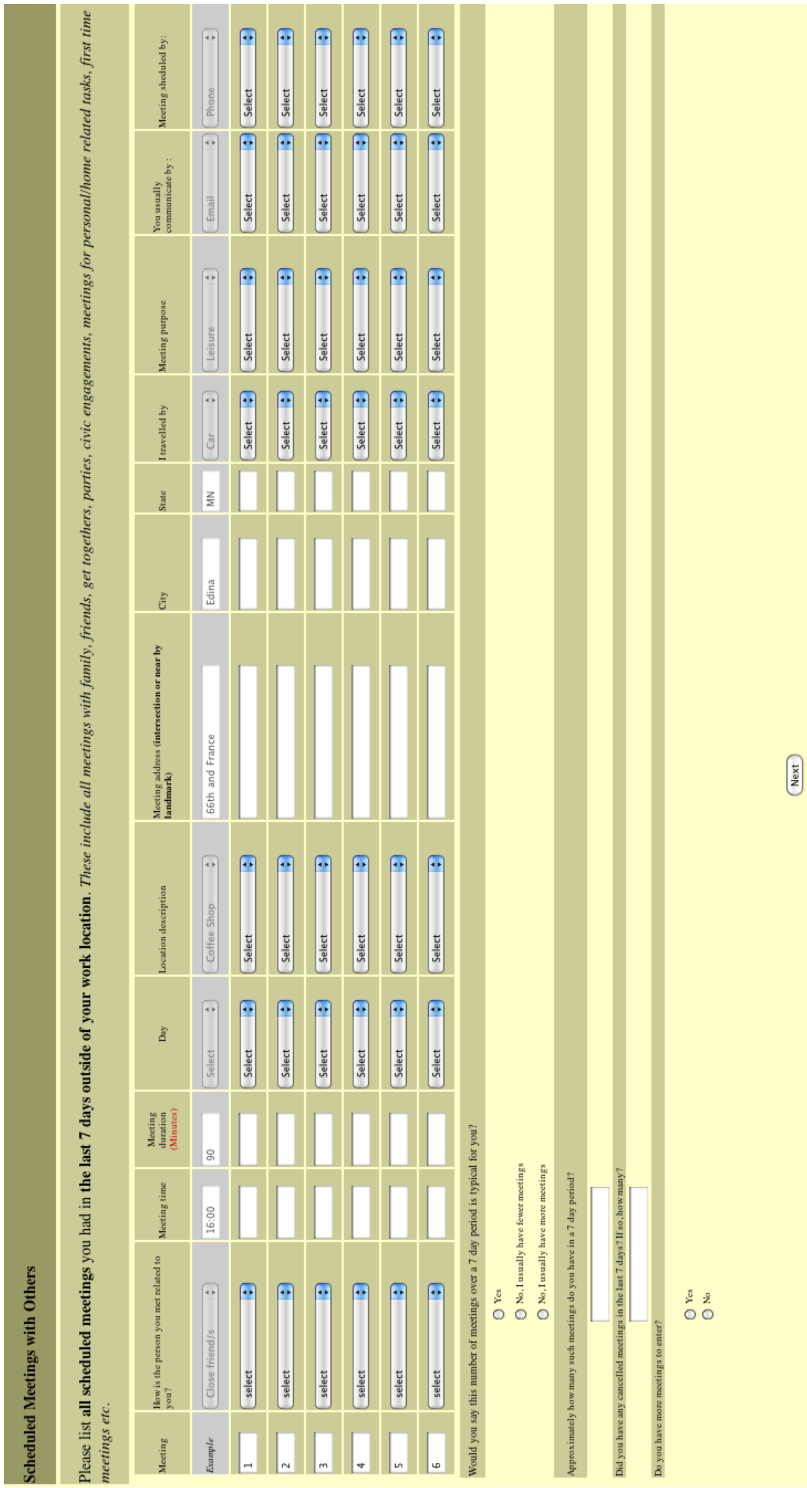
How many friends and family members do you have that you **meet in person at least twice a month?**

How many of your **closest friends** did you meet at...

Work
Church
Child's school
Neighborhood
Your school
On the internet
Social culbs (e.g. Book clubs)
Grew up together

Next

Figure B–6: Survey page 6



Scheduled Meetings with Others

Please list **all scheduled meetings** you had in **the last 7 days outside of your work location**. *These include all meetings with family, friends, get togethers, parties, civic engagements, meetings for personal/home related tasks, first time meetings etc.*

Meeting	How is the person you met related to you?	Meeting time	Meeting duration (Minutes)	Day	Location description	Meeting address (**intersection or near by landmark**)	City	State	I travelled by	Meeting purpose	You usually communicate by :	Meeting sheduled by:
Example	Close friend/s	16:00	90	Select	Coffee Shop	66th and France	Edina	MN	Car	Leisure	Email	Phone
1	select			Select	Select				Select	Select	Select	Select
2	select			Select	Select				Select	Select	Select	Select
3	select			Select	Select				Select	Select	Select	Select
4	select			Select	Select				Select	Select	Select	Select
5	select			Select	Select				Select	Select	Select	Select
6	select			Select	Select				Select	Select	Select	Select

Would you say this number of meetings over a 7 day period is typical for you?

- Yes
- No, I usually have fewer meetings
- No, I usually have more meetings

Approximately how many such meetings do you have in a 7 day period?

Did you have any cancelled meetings in the last 7 days? If so, how many?

Do you have more meetings to enter?

- Yes
- No

Next

Figure B–7: Survey page 7

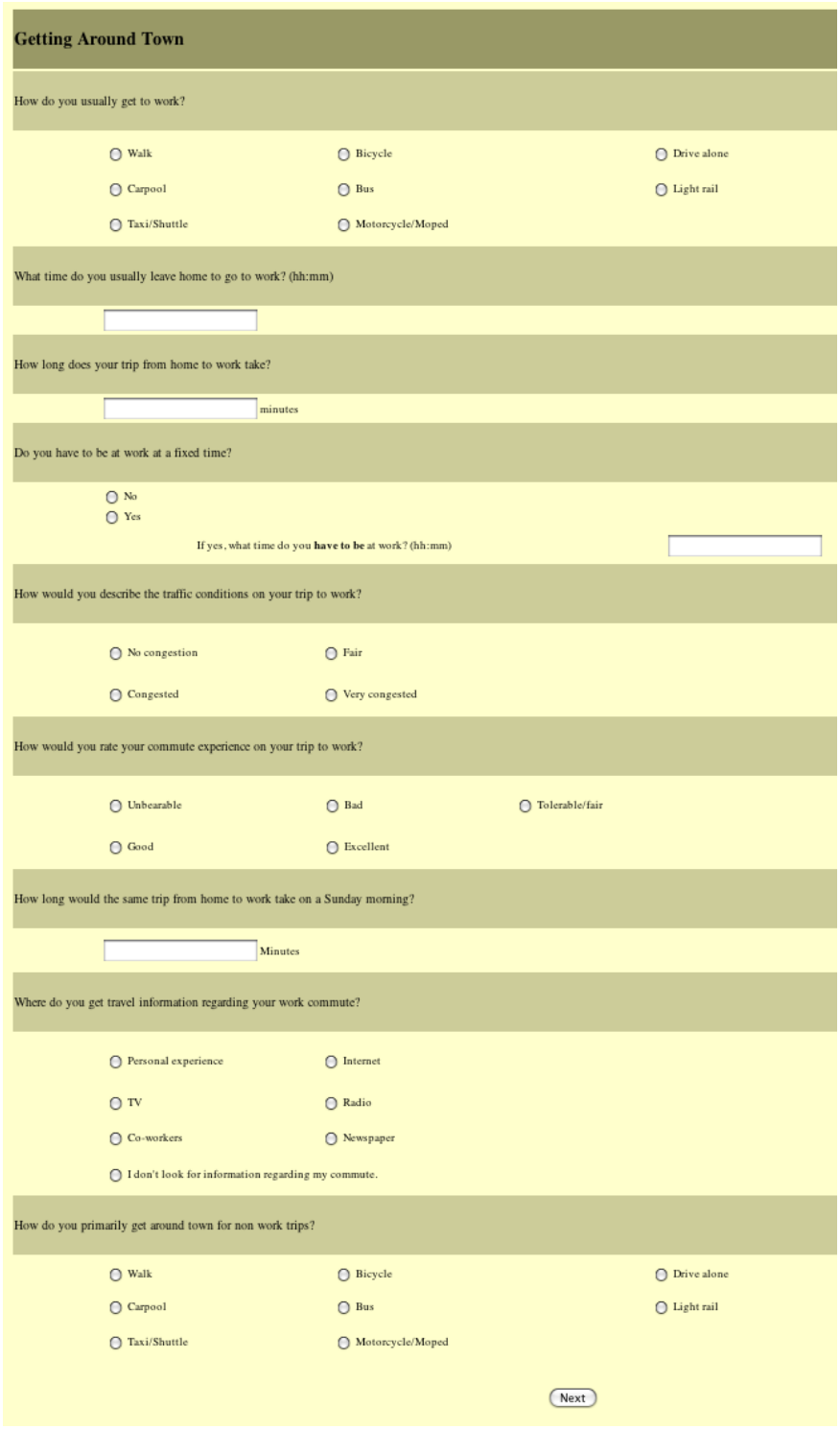


Figure B–8: Survey page 8

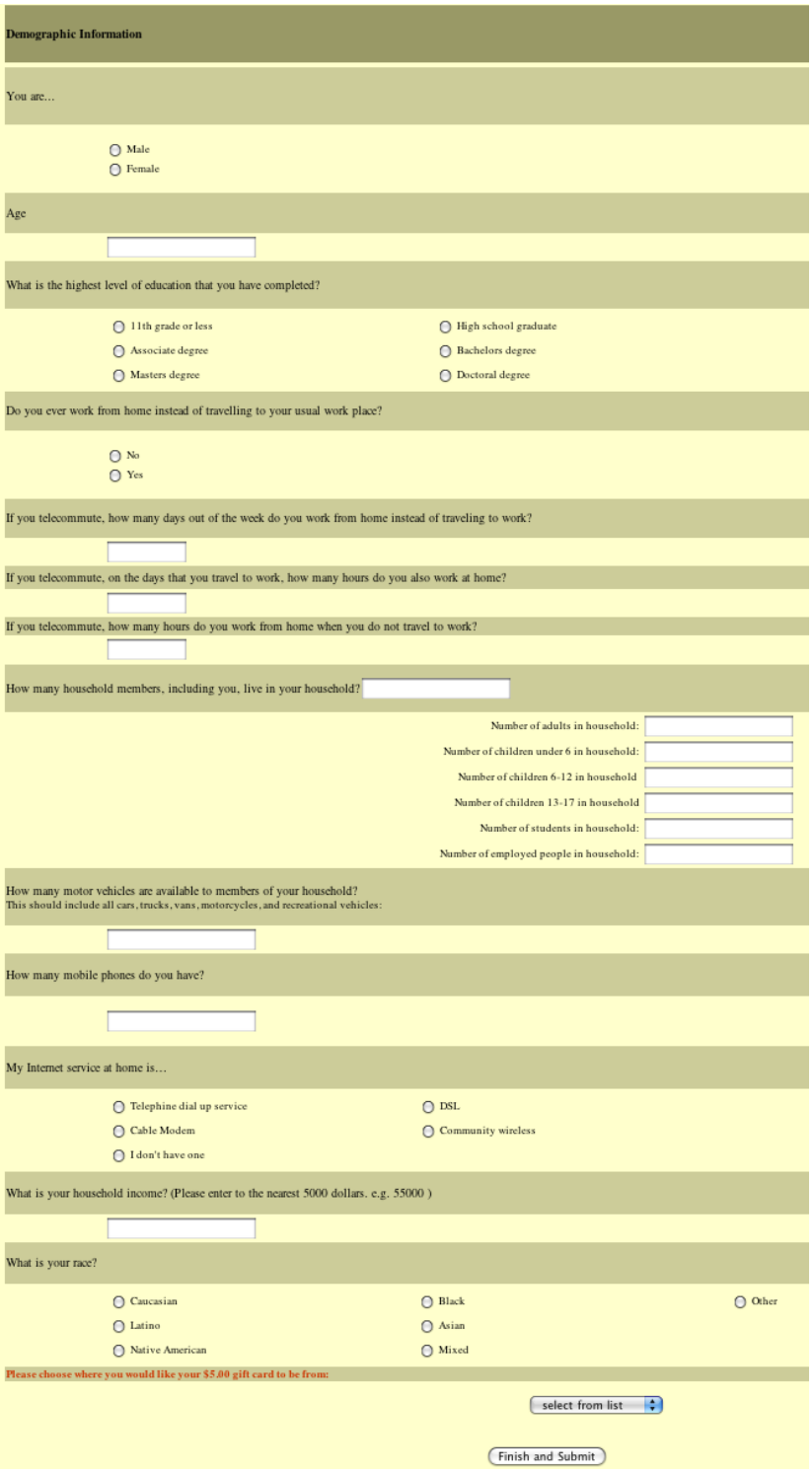


Figure B–9: Survey page 9