

# **Interregion-Occupational Persistence and Dispersion: A Model of Geographic and Occupational Mobility**

By

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**Abstract:** This paper represents the first attempt to develop a set of loglinear models that synthesize gravity models of interregional mobility and loglinear models of occupational mobility. The development of the model is progressed from a simple two-way mobility table analysis to a three-way analysis that controls for one aspect of mobility while investigating another and eventually to a four-way analysis that simultaneously assesses the joint effect of occupational and geographic mobility. An example based on data from the 1970 United States census demonstrates that the models can effectively capture the joint effect of occupational and geographic mobility. The results show that as far as interregional migration is concerned, people were not necessarily more likely to have occupational persistence. Interregional migration was positively associated with both upward and downward occupational mobility, and the propensity for upward mobility was slightly greater than that for downward mobility. Females were likely to be disadvantaged when they remained in their regions. When females moved to other regions, however, their chances of upward mobility were about the same as those of males.

**Note:** Occupation can be ranked according to its prestige or income potential. Movements across occupation ranks over different generations (e.g., father and son) are called intergenerational social/occupational mobility, while movements over a period of time are called intragenerational social/occupational mobility, which is the focus of the current paper.

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## 1. Introduction

Geographic mobility refers to the propensity of changing geographic locations, and occupational mobility refers to the propensity of shifting from one occupation to another. There are a number of parallels and recognized relationships between occupational mobility and geographic mobility. First, the age profile of geographic mobility (Rogers, 1986) is similar to that of occupational mobility (Kaufman, and Spilerman, 1982; Markey and Parks 1989; Tuma 1985), with young people moving more frequently than the elderly. Second, people with a higher socioeconomic status or educational level tend to change their locations and occupations more frequently than those in lower socioeconomic categories (Ellis et al., 1993; Long 1973). Third, “push” and “pull” factors often act to determine location and career preferences. In a relatively overcrowded regional job market, people are pushed to other regions to find a job (Plane and Rogerson 1991; Clark and Ballard 1980); in an overcrowded occupation, people are crowded out into other occupations (Rotolo and McPherson 2001). Finally, people tend to move short distances in terms of both geographic mobility (Fotheringham 1981) and occupational mobility (Scoville 1969; Rotolo and McPherson 2001). Geographic distance effects on migration are often measured according to interregional and intraregional mobility, while occupational distance effects can be captured through broader interoccupational and intraoccupational categories (Stier and Grusky 1990). Both occupational mobility and geographic mobility (OG mobility, hereafter) present mechanisms for self-adjustments at both the individual and societal levels, thus making it important to properly document and measure OG mobility.

Despite the recognition of these parallels and relationships, few researchers have attempted to explain how migration and occupational change interact with each other (Odland 1988; van Ham *et al.* 2001). Two problems have particularly plagued past research on OG mobility. First, researchers often focus on either migration or occupational change because of data constraints. Surveys focused on geographic mobility often do not collect detailed occupational mobility variables or *vice versa* and, as a result, researchers rarely cross-tabulate geographic mobility and occupational mobility tables simultaneously, let alone explain their joint effects. The vacancy chains theory, for instance, was utilized to model the system of job matching (White 1970). Sociologists use it to explain occupational mobility and career advancement (Smith and Abbott, 1983; Stewman 1975), and geographers use it to explain interregional migration flow (MacKinnon and Rogerson 1980; Emmi 1987), but no one has integrated these two perspectives in an empirical study. Second, even when data on migration and occupational changes are available, sorting out multidimensional relationships between geographic mobility and occupational mobility tables is methodologically challenging. In the United States, for instance, the 1970 census, the Panel Survey of Income Dynamics (PSID), and the National Longitudinal Survey of Youth (NLSY) contain information about migration and occupation changes. Several scholars have used these

data sets to separately examine occupational or geographic mobility (Bartel 1979; Wilson 1985; Krieg 1997; Bernhardt *et al* 2001), but none of them examine OG mobility jointly, which is vital to understanding how individual occupational opportunities interact with regional occupational opportunity structures in the system of job matching.

The current study represents the first methodological attempt to model joint OG mobility simultaneously and to assess how the individuals' propensity of remaining within a broader occupational family (occupational persistence) or changing to different occupational groups (occupational dispersion) interacts with their interregional mobility. Based on the literature review on OG mobility in section 2, section 3 introduces a set of log-linear models that synthesize the gravity model of migration and the contingency table analysis of occupational mobility. Empirical data and estimations of OG mobility are described in section 4, which is followed by a discussion of the results in the final section.

## **2. Previous Literature on Occupational and Geographic Mobility**

People vote with their feet and minds. The common notion that “the grass is greener elsewhere” reflects both geographic and occupational opportunities. In a land of perfectly free mobility, that is, without any associated moving costs, people are expected to move rather frequently from one location to another. In a society without any occupational prestige, where only a few restrictions on occupational choices exist, people are expected to move rather fluidly among occupations. The existence of migration costs and structural frictions, and how they affect migration and occupation changes, has been subjects of a considerable number of studies. These include studies that examined the interrelationship between migration and occupational change.

One of earliest conceptualizations of OG mobility is found in Blau and Duncan's (1967) classic study of *American Occupational Structure*. In their view, a region's socioeconomic conditions can be perceived to be a resource endowment of individuals. Since regions do not move, individuals who consider that their region impedes their career advancement prospects may choose to move to other regions that better suit their careers. In other words, the region's socioeconomic condition is part of what governs the region's labor demand (Blau 1992). Since the stronger economy in the northern United States posed a greater labor demand between 1900 and 1960, the region provided greater career opportunity than did the southern United States during that the same period. This partly explains why more upward occupational mobility was found in the North than in the South.

When it comes to empirical studies, however, most investigators control for either migration or occupational change while investigating the other. With regard to occupational mobility, Gleave and Palmer (1977) posited that highly skilled people are more likely to move across occupations but not locations. They reasoned that higher occupational status reflects a higher degree of transferability of

occupational skills. They also reasoned that individuals with such skills are more flexible about moving across occupations locally, implying that they are less likely to migrate to other labor markets. When they empirically tested their position, however, they did not find supportive evidence. In a more limited situation, Pashigian (1979) found that occupations requiring specific skills, such as judges, legal professionals, and dentists, were geographically less mobile. The extent to which the skills of an occupation are transferable apparently provides a natural bridge between occupational and geographic mobility.

Sex also affects occupational choice, which in turn affects geographic mobility. Since females generally hold low-skill and low-reward jobs, they are less likely than males to experience occupational changes, especially upward changes that also involve relocations (Felmlee, 1982). But when females are the primary breadwinners in their families, they are as likely to relocate as their male counterparts (Markham et al., 1983). Greenhalgh and Stewart (1985) reported similar findings from a 10-year national longitudinal survey conducted in Britain, in which females were as likely as males to move upward in both high-skilled and low-skilled occupations. In the mid-level occupations, however, males advanced with greater degrees of occupational mobility than did females.

From the viewpoint of geographic mobility, Zimmer (1973) used a sample from three metropolitan areas to investigate the relationship between mobility and occupation compositions. He found that movers, mostly from rural to urban areas, were associated with upward occupational changes. It is unclear, however, if the corresponding stayers (presumably within the urban areas) would be similarly upwardly mobile. Examining the so-called nonmetropolitan turnaround, Stinner et al. (1992) found that young males tended to reduce their occupational status when they moved from metropolitan to nonmetropolitan counties. These processes, as noted by Fielding (1992) in England, provide region-specific channels for occupational mobility. Fielding coined the term *escalator region* as a metaphor to describe occupational mobility as an interregional migration process: people moving into the Southeast of England step on the escalator; as they move up occupationally, they also get older; and for one reason (e.g., career move) or another (e.g., retirement), they eventually step off the escalator region and move on. He also found a positive relationship between occupational changes and geographic mobility. The latter result is consistent with Schlottmann and Herzog's (1984) findings in the United States: individuals who changed occupations have a higher likelihood to migrate than those who did not change occupation.

Recognizing close connections between population movement and economic structure at different geographic scales, Wilson (1984, p. 268-279) proposed a grander interconnected modeling system, wherein aggregated changes in geographic and residential locations over time are modeled together with broad occupation categories. In Wilson's model, origin-destination pair and employment types index the movements within geographic regions, and these movements can be modeled as flows or cell counts of a

multiplicative (or log-linear) model that was originally developed for entropy maximization. Since employment is indexed by changes in time, occupational mobility is implicitly included in the model. Odland (1988) explicitly modeled the joint decision on choices of residence and occupation at the individual level using a logit model. In the context of labor force entrance, an individual can move from location  $i$  to  $j$  and from occupation  $a$  to  $b$ , but the combined utility of an individual in the current occupation and location must be greater than his or her previous occupation-location specific utility. When an individual chooses to relocate from  $i$  to  $j$  and changes occupations from  $x$  to  $y$ , the utility of this joint decision must be higher than that of 1) staying put (not moving and not changing in occupation), or 2) the same move without changing occupation, or 3) the same change in occupation without moving, or 4) moving to another place ( $j$ ) and changing to another occupation ( $y$ ). Certainly, if the individual decides to stay, the utility of not moving must be greater than the utilities of all other OG mobility combinations.

Even though Wilson's model is based on aggregated job flows within a region and Odland's model is based on the individuals' decisions, the two are intrinsically similar. From the statistical standpoint, the log-linear model in Wilson's formulation and the logit model in Odland's formulation follow the same sample assumptions (Agresti, 1990; Bennett and Haining, 1985), and both can be estimated *via* the maximum likelihood method. If all the individual characteristics are categorical, Odland's individual decision model will yield identical results as Wilson's aggregated multiplicative model when both models are constrained in the same way (Lin, 2003). In fact, Odland used a log-linear model in his empirical estimation of occupational choice among labor force entrants. Since labor force entrants do not have occupational origins, the model became a reduced version of Wilson's multiplicative model, which only models labor force entrants' occupational destination choices (two professions) in combination between occupational and geographic categories (rural, urban, metropolitan). The origins and destinations of both occupational and geographic movements have not been simultaneously evaluated.

We intend to simultaneously measure origin-destination movements of OG mobility. We use the concepts of persistence and dispersion to capture staying or moving and degree of mobility within the empirical findings of OG mobility as reviewed in this section. Persistence is the propensity that people move within their occupational groups or within a region, which reflects the fact most geographic or occupational moves are over short geographic distances or are closely related occupations. Conversely, we can use the concept of dispersion to measure the propensity of moving away from one's origin-occupation and origin-region. For instance, if movements among different occupational groups are strong, they reflect occupational dispersion to either upward or downward mobility. Our task is to use these measures to test some of the hypotheses or empirical findings.

### **3 Overall Evaluation of OG Mobility Using a Gravity Model**

**Data.** Due to the methodological emphasis of the study, we use the 1 percent PUMS of the 1970 United States census population, which contains detailed occupation codes for individuals in 1970 and 1965. This data set is superior to other data sources for several reasons. First, the census uses Blau and Duncan's (1967) broad ten-category occupational rank, which takes into account the nonmonetary rewards to occupations, and has been used extensively by sociologists (Stier and Grusky, 1990; Hout 1988). We can adopt this ranking in the modeling exercises without getting into measurement issues of how to rank occupational reward. Second, it has a large sample size that allows cross-tabulations by occupations and detailed census geographic units, such as states or census divisions. We selected the sample from the 48 contiguous states and the District of Columbia and constructed the origin-destination geographic and occupational mobility table based on the respondents' occupations and states of residence in 1970 and 1965. If a person changed his or her state of residence and occupation, we assumed that both changes were related. Since labor force entrants and exits do not have occupational codes, we could not define their occupational mobility and had to exclude them. Also excluded were those persons who were under 16 years of age in 1965, were retirees, or lived in group-quarters. The final sample included 580,981 observations.

**[Tables 1 and 2 are about here]**

Comparing transition probabilities for 9 census divisions and 9 occupation categories in Tables 1 and 2, we find that people between 1965 and 1970 tended to shift more often occupationally than inter-regionally, since the diagonal percentages are less dominant in the occupational mobility table than those in the geographic mobility table. For instance, the lowest propensity of staying within the same region occurred in region 8 (Mountain Division), with 89% staying and 11% moving to other regions. Farmers had the lowest propensity of staying within their occupation category, with 59% staying and 41% moving to other occupations. Our modeling approach in describing these phenomena is to first separately model tables 1 and 2 using the conventional gravity model and then to combine the two mobility tables using higher dimension log-linear models. We estimated all of the models in SAS 8.0, but they can also be estimated using S-Plus, SPSS, or STATA with almost identical results.

**Two-way models.** We adopted Wilson's modeling framework and used its equivalent log-linear modeling approach to capture both geographic and occupational mobility. Many sociologists use log-linear models to analyze social and occupational mobility tables (Hauser, 1980), and many geographers use gravity models (a special type of log-linear model) to model interregional migration flows (Willekens,

1983). These log-linear models are similar to Maddala and Lee's (1976) simultaneous models of discrete dependent variables. The difference, as Stapleton (1980) pointed out, is that the log-linear models, by their nature of modeling cell counts, do not explicitly define the dependent and independent variables. This property is appropriate for evaluating the joint effect of geographic and occupational mobility because of the need to avoid the conventional approach of defining geographic mobility as a function of occupation mobility or *vice versa*.

For the two-way geographic mobility table, we can set out a doubly constrained gravity model:

$$m_{ij}^{od} = \tau \tau_i^o \tau_j^d v_i d_{ij}^\lambda \quad 1$$

wherein  $m_{ij}$  is the expected frequency from origin (o)  $i$  to destination (d)  $j$ ,  $\tau$  represents the grand mean,  $\tau$  parameters with a single-subscript represent marginal effects, and the superscripts  $o$  and  $d$  label origin and destination, respectively.  $\tau$ -terms multiply to 1 along appropriate dimensions (Lin 1999), and each  $\tau$  parameter can be expressed as a multiplicative effect of the grand mean.  $\lambda$  is a global measure to capture distance effect between any distance-pair ( $d_{ij}$ ) in the mobility matrix. In the context of interregional or interstate migration models, the distance often takes the form of the natural log or the log-distance. Like all double-constrained gravity models, controlling for the marginal effects is necessary to ensure that the total expected flow from each origin, or to each destination, is identical to the observed flow. When a gravity model is estimated, diagonal elements ( $i=j$ ) are often deleted to remove the immobility of a region or intraregional holding power. An equivalent procedure is to saturate diagonal elements, providing each a parameter to fit the observed frequency exactly (Lin and Xie, 1998). In equation 1 above, the latter procedure is adopted, in which the diagonal elements or intra-regional movers are fitted exactly with  $v_i$  to control for the regional holding power. This procedure is necessary for modeling the joint OG mobility, because many intraregional movers would change their occupations but not geographic regions.

The equation can be estimated with the maximum likelihood method, and the goodness-of-fit statistics can be computed for any nested model (Appendix I). Taking the natural-log on both sides of the equation yields a log-linear model. Under the log-linear modeling framework, a model with the main effects without interaction terms (or without  $v_i$  and  $d_{ij}^\lambda$  in the case of equation 1) is known as an independence model. When the independence model accounts for each diagonal element, it becomes a quasi-independence model (Agresti, 1990). In the context of equation 1, the quasi-independence model means that the  $\lambda$  is zero.

Similarly, we can set out a multiplicative model for the occupational mobility (Table 2) with the expected flow of  $m_{xy}$  being:

$$m_{xy} = \tau \tau_x^f \tau_y^t v_x d_{xy}^\lambda \quad 2$$

wherein  $f$  and  $t$  denote origin-occupation (row) and destination-occupation (column), respectively, and  $v_x$  controls for diagonal elements indexed by  $x$ . Like equation 1, the  $\tau$  parameters are subject to the normalization constraint, that is, they multiply to 1 along appropriate dimensions. Analogous to the gravity model,  $\lambda$  is the global parameter of the ordinal distance effect (e.g., 1,2,...,9) of the occupational mobility matrix. Due to the ordinal nature of the distance, the “distance” effects can be modeled for upward and downward mobility separately. For instance, if we use 1 as the highest occupational rank or status and 9 as the lowest, a move from a high number to a low number would be considered upward (or movements within the lower off-diagonal cells in Table 2) and a move from a low number to a high number would be considered downward (or movements within the upper off-diagonal cells in Table 2).

Using equations 1 and 2, we can broadly describe the two aforementioned mobility tables separately (Table 3). The independence model assumes perfectly free mobility, i.e., people move equally from all origins to all destinations including their own regions. Obviously, most people do not move between regions, hence the model fits poorly with a deviance in the magnitude of a million. Nevertheless, it provides a good reference point for model comparison. After controlling for the diagonal elements, the quasi-independence models for both mobility tables improve drastically over their corresponding independence models. For instance, with the cost of just 9 degrees of freedom, the likelihood ratio statistic  $G^2$  for the geography model is reduced to 8,696, which is a 99.6% reduction from the corresponding independence model. With an additional distance parameter  $\lambda$ , the likelihood ratio statistic  $G^2$  is further reduced to 2,295, a 74% reduction from the quasi-independence model. For the occupational mobility table, the quasi-independence model reduces the deviance by 97.7% from its corresponding independence model. It is also clear from Table 3 that models for geographic mobility fit better than corresponding models for occupational mobility. The main reason for this difference in fit was that there are greater dispersions in the occupational mobility, as observed in Table 2. In addition, the ordinal occupational distance is less “real” than the geographic distance, which may explain why the gravity model for occupational mobility fits less well than the corresponding geographic model; the former model reduces deviance by 74% the latter model only by 57% over their corresponding quasi-independence models. The “distance decay effect,” however, is evident; the log-linear parameters are  $-1.001$  and  $-0.271$  for geographic and occupational distance effects, respectively. Overall, between 1965 and 1970 people were less likely to move greater distances both geographically and occupationally.

**[Table 3 is about here]**

**Three-way and Four-way Models for Overall Persistence and Dispersion Effects.** What cannot be answered from equations 1 and 2 are the effects of joint movement among different regions and different

occupations. For instance, Schlottmann and Herzog (1984) concluded that in the United States, persons who changed occupations were more likely to migrate than those who did not. To test whether occupational mobility is positively correlated with geographic mobility, we divided Table 2 into two layers—(interdivisional movers and stayers) to create a three-way table and fit it with a layer effect model (Lin, 1999) by triple-constraining or triple-controlling populations for origins, destinations, and layers:

$$m_{xyl} = \tau \tau_x^f \tau_y^t \tau_l^k v_x \tau_{il}^{fk} \tau_{yl}^{tk} \psi^k \quad 3$$

In this equation,  $\tau_{xl}^{fk}$  and  $\tau_{yl}^{tk}$  constrain occupational origins and destinations for the movers' layer relative to the stayers' layer,  $\tau_l^k$ . Like the doubly constrained model in equation 2, all  $\tau$ s and  $v$  are proper controls for population size at each marginal element.  $\psi^k$  is a dummy variable of occupational mobility, and its interaction with the layer effect  $k$  measures the joint effect. The result shows that interregional movers are much more likely to experience occupational shifts, having a significant log-likelihood of 0.1109. In other words, movers are 1.8 times ( $\exp 0.1109$ ) as likely as stayers to change their occupation categories. This result, which is essentially analogous to controlling one aspect of OG mobility while examining the other aspect, is consistent with Schlottmann and Herzog's finding.

Furthermore, if we want to model the expected flow  $M_{ijxy}$  from region  $i$  and occupation  $x$  to region  $j$  and occupation  $y$ , we can combine equations 1 and 2 in the four-dimensional space:

$$m_{ijxy} = \tau \tau_i^o \tau_j^d \tau_x^f \tau_y^t v_i v_x d_{ij}^\lambda d_{xy}^\lambda d_{ij^*xy}^\lambda d_{ij^*r}^\lambda \quad 4$$

In this equation, all the  $\tau$  and  $v$  parameters are various controls, constrained identically as in equations 1 and 2. When equation 4 has  $\tau$  terms only, it is an independence model; when it includes both  $\tau$  and  $v$  parameters, it is a quasi-independence model. As in the previous models, we fit each diagonal cell exactly with a  $v$  parameter. The  $\lambda$  parameters indexed by  $ij$  and  $xy$  capture geographic and occupational “distance decay” effects, respectively. The additional  $d_{ij^*xy}^\lambda$  and  $d_{ij^*r}^\lambda$  parameters capture the interaction effects between geographic and occupational distance and between geographic and occupation-origin rank ( $r$ ), respectively. These  $\lambda$  parameters can enter the model sequentially to compare the goodness-of-fit statistics or to test some hypotheses. For instance, we can test the hypothesized inverse relationship between occupation ranks and geographic distances (Gleave and Palmer, 1977) by reordering occupational ranks with 9 being the highest and 1 being the lowest, and by using this ranking to interact with geographic distance-- $d_{ij^*r}^\lambda$ . If the log-linear parameter for  $d_{ij^*r}^\lambda$  is negative and significant, it is likely to confirm Gleave-Palmer hypothesis; if the parameter is positive and significant, then it suggests that higher occupational strata are associated with greater migration distances.

Table 4 lists the results. We use the quasi-independence model as the baseline (Model I), which assumes that the  $\lambda$ s in equation 5 are zero, which means that people move freely when immobility in the diagonal elements are controlled for. The model has a  $G^2$  of 73,027 with 4,125 degrees of freedom. Model II, which includes two additional distance decay terms, has a  $G^2$  of 49,464 with 4,123 degrees of freedom, and it improves the model fit by 32% percent  $(1-49,464/73,077)$  with the cost of 2 degrees of freedom. The subsequent models are to measure joint OG mobility effects. In all the models, separate distance effects for both geographic and occupational mobility are negative and significant. The third model assesses the interaction of the two distance effects or a joint distance effect of OG mobility. The interaction term,  $\lambda d_{ij^*xy}$ , is positive and significant, and its inclusion improves the goodness-of-statistic substantially from a  $G^2$  of 49,464 to a  $G^2$  of 45,858. This result suggests that given the general propensities of moving in shorter distances both geographically and occupationally, for those persons who moved to another region between 1965 and 1970, the greater the distance covered by the move, the greater the occupational strata those persons were likely to depart.

**[Table 4 is about here]**

To test the relationship between occupational rank and migration distance, the  $d_{ij^*xy}^\lambda$  in model III was replaced with the interaction term ( $d_{ij^*r}^\lambda$ ) between geographic distance and occupation-origin ranking in model IV. The interaction term was positive and significant, suggesting that model IV rejects Gleave-Palmer's hypothesis. However, model IV was worse off in terms of the likelihood ratio statistic than model III for the same number of degrees of freedom, so we reinserted the  $d_{ij^*xy}^\lambda$  term into model V. Basically, models IV and V are consistent with conventional wisdom: people tend to move in short geographic and occupational distances. If they decide to move across regions and occupations, however, the geographic distance becomes greater and the further away they are from their original occupations. For those who did change occupations between 1965 and 1970, the higher their occupational strata, the greater the distance they had moved. Since the parameter estimates are expressed in log-odds, we can transform them into odds ratios for intuitive interpretations. For instance, the 0.0215 log-odds of the  $d_{ij^*r}^\lambda$  term correspond to the 1.0273 odds ratio. For example, if a person were employed as an operative, the estimated odds that he or she would be working in a service profession would increase by a multiplicative factor of 1.0273 ( $\exp[0.0215]$ ) for each unit increase in log-distance. If we take the four cells of being an operative in New England to finding a management position in the Pacific, the estimated

odds of being in management rather than remaining an operative are 2.379 ( $\exp[0.0215*(7-2)*\ln(3,174 \text{ miles})]$ ) times for moving to the Pacific region as for staying in New England.

#### 4. Origin-Destination Region-Specific Occupational Persistence and Dispersion

**Persistence Effect.** In equation 3, we used a dummy variable  $\psi$  to assess occupational mobility for interregional movers and stayers. We can use the same strategy to assess occupational persistence and dispersion. As reviewed earlier, persistence within broader occupational groups reflects the structure of career opportunities and persons' level of training. This can be captured by log-linear parameters measuring persistence, while other factors (marginal totals for each occupation) are purged. Analogous to intraregional mobility, it is assumed that the propensity for staying within an occupational group reflects the extent of occupational structure after controlling for population size (equation 5).

$$m_{ijxy} = \tau \tau_i^o \tau_j^d \tau_x^f \tau_y^t v_i v_x \tau_{ij}^{od} (\tau_{ij}^{od} * \psi) \quad 5$$

Instead of distance parameters in equation 4, we use  $\psi(1,2,3,4)$  to represent the persistence (or holding power) of occupational groups. Here, the four occupationally persistent categories are adopted from Stier and Grusky (1992) and are ranked from highest to lowest: upper nonmanual (consisting of managerial, professional occupations); lower nonmanual (consisting of sales and clerical occupations); upper manual (consisting of precision, craft, and service occupations); and lower manual (consisting of operatives, laborers, farmers, and farm laborers). Within this framework, occupational persistence is tantamount to a value of  $\psi$ , so we compared occupation persistence within each of the four broader groups with movements among other categories for each geographic origin and destination pair. For ease of exposition in graphic form, we further regrouped the regions into the four census regions of Northeast (N), North Central, or Midwest (M), South(S), and West (W). The results (Fig. 1) are shown as odds ratios or multiplicative parameter estimates. An odds ratio of greater than 1 (or a positive log-linear parameter) represents a strong persistence effect, while an odds ratio of less than 1 represents a weak persistence effect or a stronger propensity to move into another occupational group. These effects are displayed in Figure 1 for each origin-destination combination among the four regions.

**[Figure 1 about here.]**

Overall, the persistence parameters are strong for intraregional migrants and upper nonprofessionals. Even though staying within their regions was generally a plus for remaining in the upper nonmanual professions, interregional movers between the Northeast and Midwest had the greatest persistence. Since regional migration flows were already fitted exactly, the occupational persistence is

the net of population size effects among various origin-destination pairs in the geographic mobility. The strong persistent effects for low-manual intraregional movers were attributable to those who stayed in the regions. For interregional movers, those in lower manual and lower nonmanual groups were generally less likely to be persistent or more likely to disperse to other occupation groups. The two exceptions of greater persistency were low nonmanual migrants from the Northeast to the South and lower manual migrants from the South to the Midwest. Since intraregional movers and stayers dominate an occupational mobility table, the results suggest that strong occupational persistence was common only among intraregional movers and stayers in general and upper nonmanual professions in particular. Interregional movers typically had weak occupational persistence and were more likely to move to other occupational groups. Furthermore, in contrast to other occupational groups, those in upper manual professions were less likely to stay within their occupation group regardless of regional destinations. This result suggests that a decline in craftsmen/precision workers and an increase in service workers in the 1960s were more likely to occur through exchanges between upper manual and other occupational categories.

**Dispersion Effect.** Occupational dispersion can occur either through upward or downward movements. We developed a model to describe the propensity of upward and downward mobility based on equation 5. To enable comparisons between upward and downward mobility, we had to add upward/downward mobility parameters ( $\varepsilon_{hij}^{sod}$ ) and to fit interregional flows exactly ( $\tau_{ij}^{od}$ ) so that any variation caused by interregional migration flows could be removed.

$$m_{ijxy} = \tau \tau_i^o \tau_j^d \tau_x^f \tau_y^t \nu_x \tau_{ij}^{od} (\varepsilon_{hij}^{sod}) \quad 6$$

In equation 6, the term  $\varepsilon_{hij}^{sod}$  indexes parameters for the number of occupational strata to be crossed. Note also that by fitting all the regional flows exactly, the parameter  $\varepsilon_{hij}^{sod}$  reflects the propensity of upward or downward mobility by each origin-destination pair.

**[Figure 2 about here.]**

With reference to the intraregional upward movers, Figure 2 shows the odds ratios for upward and downward mobility for each origin-destination pair in two-letter combinations (e.g., NS stands for migration from the Northeast to the South). Overall, interregional migrants had greater chances for either upward or downward mobility. In other words, staying in one's region normally will reduce the chance for occupational mobility. Amid this general trend, the propensities of upward mobility slightly outpaced

downward mobility for most interregional migrants, and there was substantial regional variation. The Midwest and the South were occupational escalators. Except for individuals migrating from the Northeast, those who moved to a different region were more likely to move upward, with the greatest likelihood of moving from the South to the Midwest. These results reflect regional economic dynamics to some extent. In the later half of 1960s, the South was in the process of becoming a new economic powerhouse, attracting not only individuals in the manufacturing sector but also those in the management and service sectors.

Although females are generally less likely to move upward, those who relocate within an organization have an opportunity of upward mobility that is fairly comparable to that of males (Felmlee, 1982). To evaluate gender effects in the context of interregional migration, we estimated equation 6 for males (Fig. 3a) and for females (Fig. 3b). In this case, we arranged the odds-ratios from lowest to highest according to the odds-ratios for males. We found that there was no clear advantage for males among interregional movers but the likelihood of males moving upward if they stayed within their regions was greater than that of females. Just as different occupations presented different opportunities for males and females, so did different regions. Females could take advantage of regional opportunities by moving to other regions; in all likelihood, they not only fared better than if they had stayed in their own regions but sometimes also had better opportunities than did males. For instance, when compared with males, females had a greater likelihood of upward mobility if they moved from the Northeast to other regions or they moved from the South or the West to the Northeast. Given these findings, it is not possible to conclude that males generally had better opportunities for advancement than did females, especially when occupational mobility was associated with interregional mobility.

**[Figure 3 about here.]**

With regard to downward mobility, however, we found that in most origin-destination pairs, females were more likely to move downward than were males. Although the opportunity for upward mobility was comparable between males and females overall, females were more likely to experience downward mobility than were males. On average, women seem to be at a disadvantage, especially if we compare the occupational opportunities of male and female intraregional movers, who account for more than 90% of the occupational movers). Since the opportunity for upward mobility generally favored males and downward mobility favored females among intraregional movers, the overall effect of moving up the job ladder will likely favor males over females.

## **5. Discussion**

In the migration and occupational mobility literature, a mobility table is often analyzed by using a gravity or log-linear model. We have presented in this paper a log-linear modeling framework that combines the two mobility tables into a four-dimensional contingency table and simultaneously permits evaluation of their joint effects. Similar to the double-constrained gravity model, all the distributional effects of population sizes are controlled for by constraining each marginal element. Hence, the model is quadruple-constrained with two constraints for migration and occupation origins and two constraints for the destinations. Following standard practices in analyzing a mobility table, diagonal cells, which represent intraregional and intraoccupational flows, are fitted exactly, so that differential immobility by region and occupation will not affect the results. Based on the 1970 United States census data, our evaluations of overall, as well as region-specific, occupational shifts represent the first attempt to model the four-dimensional mobility table simultaneously. The overall evaluation follows the typical approach to model building to evaluate both parameter estimates and the goodness-of-fit statistics. The region-specific evaluation provides a descriptive statistical tool to examine the propensities of occupational and geographic mobility, and the empirical findings shed some new light on the OG mobility literature.

Using a gravity model, our overall evaluation of OG mobility found that, given the main distance decay effects of geographic and occupational mobility, those who ventured to move in greater geographic distance tended also to cross more occupational strata. This finding, albeit not reported elsewhere, is consistent with intergenerational social (occupational) mobility (Kulis, 1991). In particular, when only the occupation-origins were ranked, we found that occupational ranks were positively associated with migration distance and thusly rejected Gleave-Palmer's hypothesis.

Second, we evaluated interregional migration-specific occupational persistence. It was found that people were not necessarily more likely to stay within a broad occupational group. Only intraregional movers and those in upper nonmanual professions had strong occupational persistence. Those in upper manual professions, which cover craft, precision production, and services, overwhelmingly had weak affinity to their broad occupational group regardless of their migration status. In the 1960s, the United States witnessed a marked decline in craftsmen, operatives, and labors and an increase in service and white collar (or nonmanual) occupations (Singelmann and Browning, 1980). These combined effects likely contributed to the fact that people who moved into service jobs were more likely to come from other broader occupational categories. Those who left their occupations as craftsmen and operatives were more likely to move to other broader occupational categories. This trend reflected a nationwide economic restructuring toward a service-oriented economy during the decade (Frey, 1987).

Third, we evaluated interregional migration-specific occupational dispersion using an example of upward and downward mobility. It was found that interregional migration is positively associated with both upward and downward occupational mobility, and the propensity for upward mobility was slightly

greater than that for downward mobility. Females were likely to be disadvantaged when they stayed in their regions. When they moved to other regions, however, their opportunities for upward mobility were about the same as those of males. Hence, stepping on an upward regional escalator can go both ways, depending upon the escalator on which people step. If they were in upward-mobility mode, moving from the West to the Midwest was the best choice for both males and females.

To conclude, we present several ways of simultaneously modeling OG mobility together with empirical results. The key in building a log-linear model is to control both marginal and diagonal elements. The key to test a specific hypothesis is to set up a proper contrast or a dummy variable, which could either be a global measure (such as a distance decay parameter) or a specific persistence or dispersion contrast. The empirical findings, although based on the 1970 census, provide baseline results for further assessment of occupational and geographic shifts in the United States. For instance, it would be of interest to explore business cycles versus long-term change on the joint decision regarding geographic mobility and occupational change among different demographic groups. In particular, women might endure recession better than men, because stereotypical female sectors, such as health care and education, tend to suffer less than male-dominated sectors, such as manufacturing and information technology.

## Appendix I

In addition to parameter estimates, the goodness of fit statistic of a model can be evaluated via log-likelihood. When the number of observations is large,  $-2L^2$  follows a chi-squared distribution pattern with the degrees of freedom being the difference in the dimensions of parameter spaces derived under two alternative hypotheses (e.g.,  $H_0$  and  $H_a$ ). Since the predicted and expected frequencies can be derived from parameter estimates, the likelihood ratio chi-squared statistic can be easily calculated:

$$G^2 = 2 \sum (\text{Observed}) \log(\text{Observed}/\text{Expected}),$$

in which the summation is over all the cells, and the expression is  $-2$  times the logarithm of the likelihood ( $L^2$ ). In the case of  $n$  regions with  $m_{ij}$  and  $\hat{m}_{ij}$  (denoting the observed and expected frequencies, respectively) for origin  $i$  ( $i=1$  to  $n$ ) to destination  $j$  ( $j=1$  to  $n$ ), we have:

$$G^2 = 2 \sum \sum m_{ij} \log(m_{ij} / \hat{m}_{ij}),$$

with the degrees of freedom being the number of log-linear parameters minus the number of linearly independent parameters. The saturated model, which fit the entire sample completely, has a 0 free parameter or a 0 degree of freedom, while the independence model has  $(n-1)(n-1)$  degrees of freedom. The likelihood ratio chi-squared statistic for the independence model is:  $-2L^2$  ( $H_a$ -independent model) with  $(n-1)(n-1)$  degrees of freedom. The task of comparing the two models is, therefore, equivalent to evaluating the difference in  $G^2$  for the two models. This model comparison strategy applies to any two alternative models with a nested parameter structure.

## References

- Agresti, A., 1990. *Categorical Data Analysis*, 1990, John Wiley and Sons, New York.
- Bartel, P. Ann, 1979. "The Migration Decision: What Role Does Job Mobility Play?" *The American Economic Review*. 69: 775-786.
- Bennett RJ, Haining RP (1985) Spatial Structure and Spatial Interaction Models: Modeling Approaches to the Statistical Analysis of Geographical Data. *Journal of the Royal Statistical Society A* 148:1-27.
- Bernhardt, Annette; Morris, M, Handcock, M and Scott, M., *Divergent Paths: Economic Mobility in the New American Labor Market*, 2001, Russell Sage Foundation, New York.
- Blau, Peter and Duncan, Otis Dudley, 1967. *American Occupational Structure*, Wiley, New York.
- Blau, Peter M., 1992. "Mobility and Status Attainment," *Contemporary Sociology*, 21:596-598.
- Clark Gordon and Kenneth Ballard, 1980 " Modeling Out-migration from Depressed Regions: The Significance of Origin and Destination Characteristics." *Environment and Planning A*, 12: 799-812.
- Ellis, M., Barff, R., and Renard, B., 1993. "Migration Regions and Interstate Labor Flows by Occupation in the United States," *Growth and Change*, 24:66-90.
- Emmi, P., 1987. "Structural Determinants of Occupational Mobility in a Regional Labor Market (US)," *Environment and Planning A*, 19:925-948.
- Feilding, A., 1992 "Migration and Social Mobility: South East England as an Escalator Region," *Regional Studies*, 26:1-15.
- Felmlee, H. Diane 1982. [Women's Job Mobility Processes Within and Between Employers](#) *American Sociological Review*,. 47: 142-151
- Fotheringham, A. Stewart. 1981. "Spatial Structure and Distance-Decay Parameters", *Annals of the Association of American Geographers*, 71: 425-436.
- Frey, William H., 1987. "Migration and Development of the Metropolis: Regional Restructuring or Rural Renaissance?" *American Sociological Review*, 52: 240-57.
- Gleave, David and Palmer, Derek, 1977. "The Relationship between Geographic and Occupational Mobility in the Context of Regional Economic Growth," in Hobcraft, John and Rees, Philip, ed., *Regional Demographic Development*, Billings and Sons, London.
- Greenhalgh, Christine, and Mark Stewart, 1985 "The Occupational Status and Mobility of British Men and Women," *Oxford Economic Review*, 37 :40-71.
- Hauser, Robert M., 1980 "Some Exploratory Methods for Modeling Mobility Tables and Other Cross-Classified Data," Pp, 413-58, in Schuessler K. F., ed., *Sociological Methodology*, , Jossey-Bass, San Francisco, CA.
- Hout, Michael, 1988 More, "Universalism, Less Structural Mobility: The American Occupational Structure

- in the 1980s," *American Journal of Sociology*, 93:1358-1400.
- Kaufman, Robert, and Spilerman, Seymour, 1982. "The Age of Occupations and Jobs," *American Sociological Review*, 87: 827-51.
- Kulis, S 1991. *Why Honor the Father and Mother? Class, Mobility and Family Ties in Later Life* New York: Garland
- Lin, G., 1999 "Assessing Structural Change in U.S. Migration Patterns: A Log-Rate Modeling Approach," *Mathematical Population Studies*, 7:217-237.
- Lin, G. 2003. A spatial Logit Association Model *Geographic Analysis* 35 (3):
- Long, Larry H., "Migration Differentials by Education and Occupation: Trends and Variations," *Demography*, 10, 1973:243-258.
- Maddala, G.S. and Lee, L., "Recursive Models with Qualitative Endogenous Variables," *Annals of Economic and Social Measurement*, v5, 1976:525-45.
- Markham, William, Bonjean, Charles and Corder, Judy, 1983. "A Note on Sex, Geographic Mobility, and Career Advancement," *Social Forces*, 61:1139-46.
- Markey, P. James and Parks II, William, 1989. "Occupational Change: Pursuing a Different Kind of Work," *Monthly Labor Review*, 3: 3-12
- MacKinnon, R. and Rogerson, P., 1980. "Vacancy Chains, Information Filters, and Interregional Migration," *Environment and Planning A*, 12:649-58.
- Krieg, R. G., 1997. "Occupational Change, Employer Change, Internal Migration, and Earnings," *Regional Science and Urban Economics Review*, 27:1-15.
- Odland, John, 1988. "Migration and Occupational Choice Among Young Labor Force Entrants: A Human Capital Model," *Geographic Analysis*, 20:281-296.
- Pashigian, Peter, 1979. "Occupational Licensing and the Interstate Mobility of Professionals," *Journal of Law Economics*, 22:1-25.
- Plane, D. and Rogerson, P., 1991. "Tracking the Baby Boom, Baby Bust, and Baby Boom Echo: Implications of Shifting Age Composition for U.S. Mobility and Migration," *The Professional Geographer*, 43: 416-30.
- Rogers, Andrei, 1986. "Parameterized Multistate Population Dynamics and Projections," *Journal of the American Statistical Association*, 81:48-61.
- Rotolo, Thomas and McPherson, Miller, 2001. "The system of Occupations: Modeling Occupations in Sociodemographic Space," *Social Force*, 79:1095-1130.
- Schlottmann, Alan M. and Herzog Jr., Henry W., 1984. "Career and Geographic Mobility Interactions for the Age Selectivity of Migration," *Journal of Human Resources*, 19:72-86.
- Schroeder, Larry D., 1976. "Interrelatedness of Occupational and Geographical Mobility," *Industrial and Labor Relations Review*, 29: 405-411.

- Scoville, James G., 1969. *The Job content of the US economy, 1940-1970*, McGraw-Hill. New York.
- Singelmann, J. and H. Browning, 1980. "Industrial transformation and Occupational change in the US, 1960-70," *Social Forces*, 59:246-264.
- Smith D.R. and Abbott A, 1983. 'A Labor Market Perspective on the Mobility of College Football Coaches', *Social Forces*, 61:1147-1167.
- Stapleton, Clare, *Limitations of Log-linear Models in Geography*, 1980, Transactions Institute of British Geography. NS 5:4
- Stewman S. (1975) Two Markov Models of Open System Occupational Mobility: Underlying Conceptualizations and Empirical tests, *American Sociological Review*, 40,298-321.
- Stier, Haya and Grusky, David, 1990 "An Overlapping Persistence Model of Career Mobility," *American Sociological Review*, 55:736-756.
- Stinner, William, Toney, Michael and Cheong, Keywon, 1992 in Jobes, P. Stinner, W and Wardwell, J. eds., *Community, Society and Migration*, , University Press of America, New York.
- Tuma, N. B., 1985. Effects of Labor Market Structure on Job Shift Patterns, in J. Heckman, B. Singer, ed., *Longitudinal Analysis of Labor Market Data*, Pp, 327-263, Cambridge University Press, MA.
- van Ham, M., Mulder, H. C., and Hooimeijer, P., 2001 "Spatial Flexibility in Job Mobility: Macrolevel Opportunities and Microlevel Restrictions," *Environment and Planning*, 33: 921-940.
- Willekens F. 1983. Log-linear modelling of spatial interaction. *Papers of the Regional Science Association* 52:187-205.
- Wilson, Alan, 1984. *Urban and Regional Models in Geography and Planning*, Pion Limited, London.
- Wilson, Franklin, 1985. "Migration and Occupational Mobility: A Research Note," *International Migration Review*, 19:278-92.
- White, H. C. 1970. *Chains of Opportunity: System Models of Mobility in Organizations*, 1970, Harvard University Press, Cambridge, Massachusetts
- Zimmer, G. Basil, 1973 "Migration and Changes in Occupational Compositions," *The International Migration Review*, 7:437-448.

Table 1 Transition probability of Interregional Geographic Mobility Table of 1965-70  
To

From	N Eng	M-Atl	EN Cen	WN Cen	S-Alt	ES Cen	WS Cen	Mtn	Pacific	Total N
N Eng	0.9598	0.0102	0.0044	0.0012	0.0136	0.0010	0.0015	0.0021	0.0062	36088
M-Atl	0.0058	0.9590	0.0063	0.0010	0.0168	0.0010	0.0017	0.0019	0.0066	115737
EN Cen	0.0015	0.0048	0.9555	0.0054	0.0124	0.0046	0.0033	0.0044	0.0081	120492
WN Cen	0.0012	0.0029	0.0144	0.9372	0.0066	0.0019	0.0092	0.0112	0.0154	47241
S-Alt	0.0026	0.0101	0.0093	0.0018	0.9586	0.0060	0.0042	0.0016	0.0058	82771
ES Cen	0.0009	0.0025	0.0206	0.0023	0.0200	0.9390	0.0088	0.0014	0.0045	33675
WS Cen	0.0009	0.0022	0.0066	0.0060	0.0068	0.0053	0.9546	0.0067	0.0109	51115
Mtn	0.0017	0.0047	0.0110	0.0129	0.0077	0.0018	0.0164	0.8897	0.0541	21551
Pacific	0.0018	0.0044	0.0071	0.0044	0.0052	0.0014	0.0073	0.0129	0.9554	72311

Table 2 Transition probability of occupational mobility: 1965-70  
To

From	1	2	3	4	5	6	7	8	9	Total N
1-professionals	0.8710	0.0399	0.0135	0.0307	0.0160	0.0162	0.0092	0.0008	0.0028	80296
2-managers	0.0421	0.7602	0.0559	0.0508	0.0348	0.0205	0.0256	0.0022	0.0078	52103
3-sales	0.0354	0.0959	0.6979	0.0745	0.0254	0.0268	0.0343	0.0012	0.0085	41637
4-clerical	0.0404	0.0328	0.0240	0.8320	0.0159	0.0226	0.0248	0.0004	0.0071	94659
5-crafts	0.0199	0.0319	0.0126	0.0178	0.8178	0.0182	0.0625	0.0021	0.0173	87220
6-service	0.0211	0.0181	0.0167	0.0494	0.0284	0.7907	0.0573	0.0008	0.0175	67887
7-operatives	0.0146	0.0172	0.0139	0.0317	0.0736	0.0342	0.7816	0.0021	0.0310	107296
8-farmers	0.0080	0.0148	0.0100	0.0102	0.0352	0.0201	0.0514	0.7651	0.0854	15559
9-labors	0.0192	0.0267	0.0172	0.0365	0.1005	0.0511	0.1435	0.0179	0.5874	34324

Note: Occupational scores (1-9) are based on Duncan 1962

Table 3. Separate model fits for geographic and occupational mobility

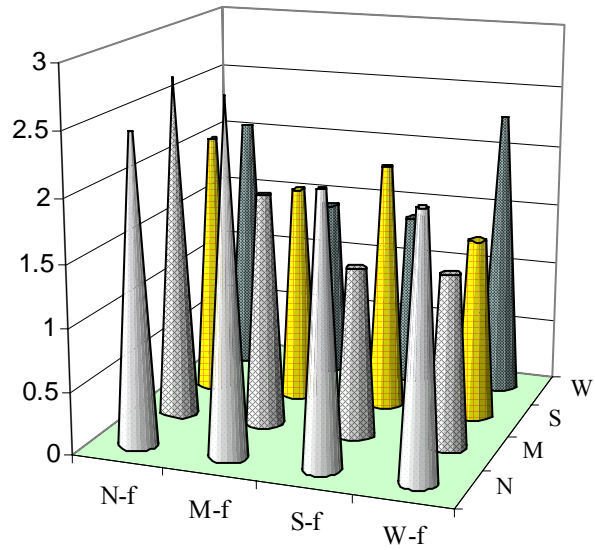
		Geographic	Occupational
Models	Df	$G^2$	$G^2$
Independence	64	2,075,883	1,377,489
Quasi-independence	55	8,696	32,315
Gravity ( $\lambda$ )	54	2,295 (-1.001)	13,830 (-0.271)

Table 4. Overall geographic and occupational distance effects

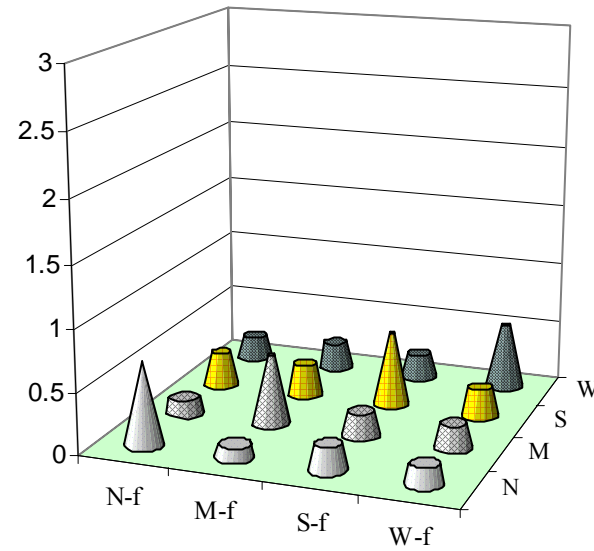
Models	df.	G2	$\lambda d_{ij}$	$\lambda d_{xy}$	$\lambda d_{ij*xy}$	$\lambda d_{ij*r}$	BI
I— Eq. 5 with only $\tau$ s and $\nu$ s	4,125	73,027					18208
II— Model I + $\lambda d_{ij} + \lambda d_{ij*xy}$	4,123	49,464	-0.9303	-0.2691			-5329
III— Model II + $\lambda d_{ij*xy}$	4,122	45,858	-0.9244	-0.2853	0.0357		-8921
IV— Model II + $\lambda d_{ij*r}$	4,122	47,034	-1.0588	-0.2689		0.0191	-7745
V— Model II + $\lambda d_{ij*xy} + \lambda d_{ij*r}$	4,121	42,693	-1.0699	-0.2881	0.04	0.0215	-12073

Figure 1. Interregional occupation persistence

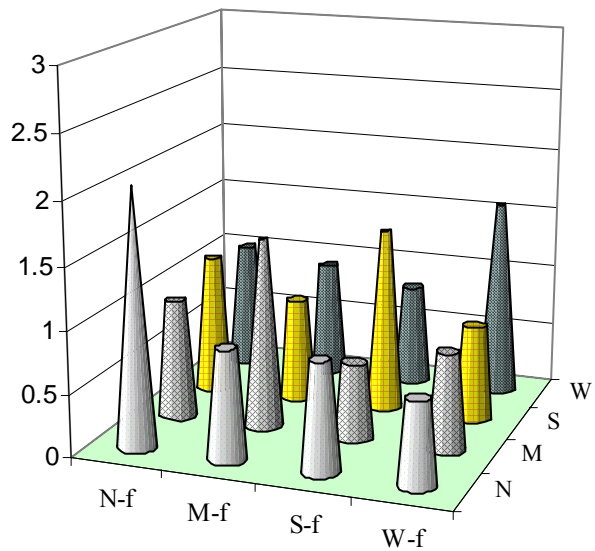
a. Upper non-manual



c. Upper manual



b. Lower non-manual



d. Lower manual

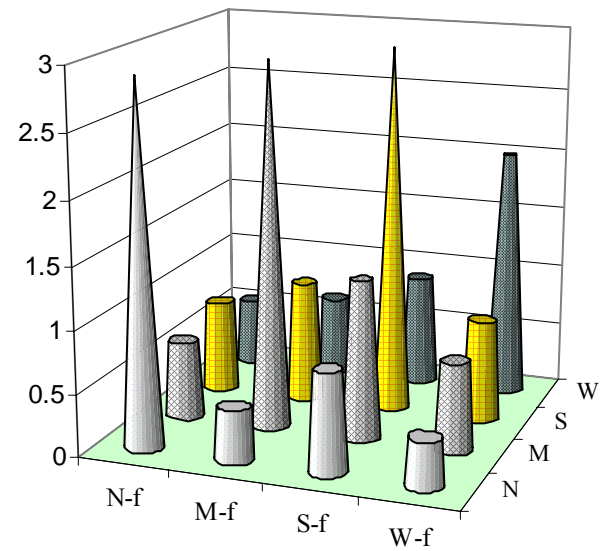


Figure 2. Odds-ratios of upward/downward mobility



