Work and Health Commuting in Mississippi

- working paper -

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Abstract

Understanding spatial flows is important for modeling regional commuting behavior. We focus on the distances people are willing to travel from home to work and examine commuting through the development and application of several gravity models. This paper examines commuting between counties in Mississippi and explores the importance of regional labor force and employment, as well as the estimation of distance deterrence parameters. We estimate gravity models of commuting to work in Mississippi for 1990 and 2000, and observe an increase in distance deterrence, and find that employment at the place of work affects commuting more than the size of the local labor force. We also propose a model for health commuting, again using the entropy-based approach, and describe a significant relationship between commuting to work and commuting for health.

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Introduction

It seems that people are always on the move. Since early settlers left the security of hearth and home to pioneer a new way of life, the "American way" has been to move ever onward. The significance of this fact is that it continues to shape our society; patterns of movement are no less important today - it is the journey to work that defines our lifestyles and the community in which we live. This is borne out by the current level of de-concentration of urban centers, or urban sprawl, a social phenomenon that is marked by an increase in worker mobility, which is reflected by changing commuting and migration patterns (Renkow M 2004).

More than 30 years ago Hoover (1971) pointed out that access advantage is measured largely in terms of the cost of the journey to work. In this paper we explore the journey to work by looking at changes in commuting patterns from 1990 to 2000 in Mississippi. We also look at commuting in the context of health care. Here we propose a gravity model of health commuting at the county level, something which has not been seen and the subject of which is rarely addressed in the current literature.

We are generally interested in the compatibility of a modeling framework historically used for journey to work, with that of journey for health. We begin by presenting some stylized facts about commuting and health care in Mississippi. Then we look to the past and outline the use and theoretical background of the gravity model, that beacon which has illuminated the progress of spatial interaction as statistical mechanics. Following this we empirically test our hypothesis with models for work and health commuting. In balance we discuss the results and suggest directions for future investigation.

Commuting and Health Care In Mississippi

Mississippi is a social frontier. There exists enormous potential for economic growth as a wealth of resources and innovation prevails. In the 2000 census 65 of the state's 82 counties were classified as rural. Perhaps all but the poorest of these have some infrastructure in place to support expansion and development. Though few of these counties have a well-established export base, there continues to be a demand by industries to locate in the state. This is evidenced by the growth of the automobile manufacturing sector, and establishment of major industrial manufacturing centers in the central part of the state – stimulating further growth and expansion of service and retail sectors.

From 1990 to 2000 the civilian labor force grew by 18% in Mississippi. Most of this growth occurred in the south and northeast areas of the state, while the lowest level of growth was in the northwest, the Delta region (Table 1).

Table 1. Civilian Labor Force in Mississippi

	1990	2000	Growth
Coast	303,624	381,883	25.7%
Delta	127,261	134,132	5.4%
Heartland	273,747	321,761	17.5%
Hills	240,904	291,850	21.1%
Plains	177,949	196,731	10.5%

Source: U.S. Census Bureau

Commuting, generally defined here as the journey away from one's county of residence, increased statewide from 1990 to 2000. In 1990 the total number of commuters was about a quarter of million and grew by 39% to more than 370,000 in 2000 (Table 2).

Table 2. Commuting in Mississippi

	1990	2000
Intrastate	207,577	296,595
Interstate*	51,872	65,626
Other	7,145	9,673
Total	266,594	371,894

Source: U.S. Census Bureau. * Adjacent states: LA, AR, AL, TN.

In-state flows to work dominated commuting patterns and rose slightly, from 77.8% in 1990 to 79.7% in 2000. This is noteworthy considering that 33 of the 82 counties border another state. One measure of the significance of commuting is the ratio of commuting to the labor force. In 1990 23.7% of the labor force in Mississippi commuted. This grew to 28% by 2000, though the patterns varied widely within the state (Figure 1).

By far the greatest increase in commuting as a fraction of the labor force occurred in the northwest part of the state, where in some counties the ratio more than doubled, clearly an indicator of substantial movement. In Figure 2 we present commuting of another kind, that of commuting for health care. Health commuting is defined as receiving health care in a county other than where one resides. Residents in more than 10% of the counties relied solely on health services away from home. In 26 counties at least 75% of those seeking health care relied on commuting.

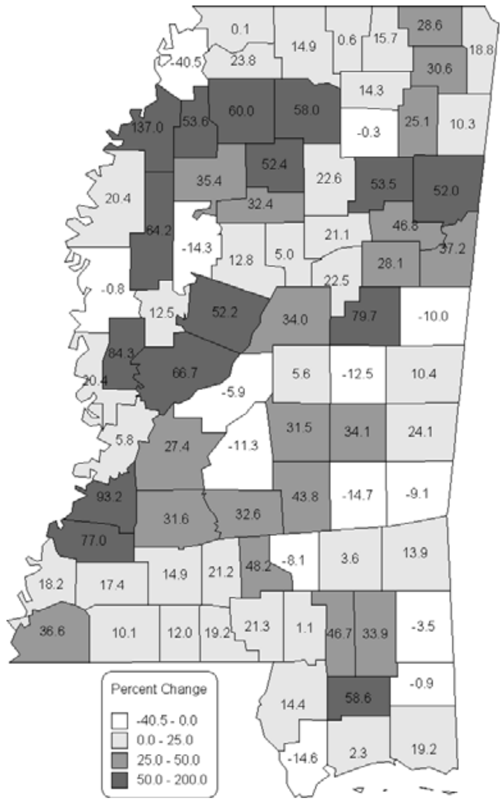

Figure 1. Change in the Ratio of Commuting to Labor Force from 1990 to 2000.

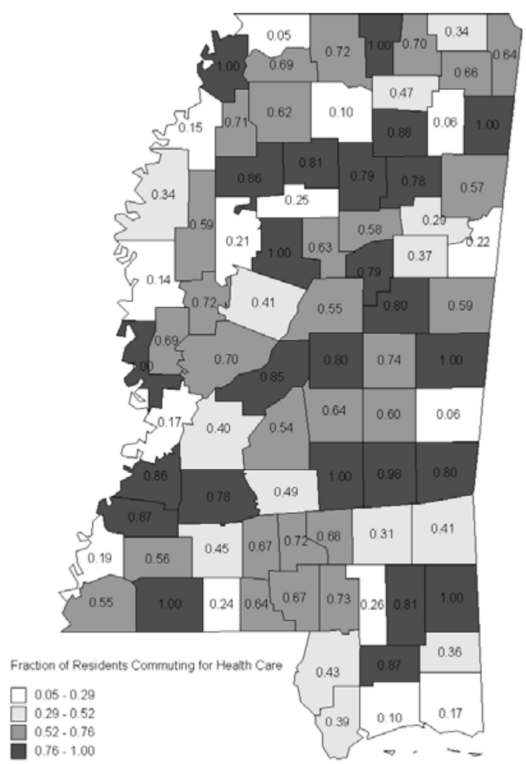

Figure 2. Commuting for Health Care in Mississippi, 2002-2003

Background

Commuting, the flow of people from one point in space to another, or across defined geographic boundaries has, for more than a century, attracted the attention of researchers. As early as 1850 social physicists put Newton's theories of gravity to work, as the flow of people was observed as an analogy to the gravitational attractions between points of physical mass. That is, the force of attraction is proportional to the product of the masses of two bodies, and inversely proportional to the square of the distance between them:

$$G_{ij} = g\, A_i\, B_j\, d_{ij}^{-2} \qquad (1)$$

where G_{ij} is the gravitational attraction between the two masses, g is the gravitational constant, A_i and B_j are the masses, and d_{ij} is the distance between them. Spatial interaction as social physics persisted through most of the 20th Century, yet by the 1970's, following Alan Wilson's successful marriage of thermodynamics to gravity (Wilson A 1970), spatial interaction was viewed in a new and more consistent framework, that of statistical mechanics (Fotheringham et al. 2000). Wilson adapted a method of statistical thermodynamics where the distribution functions of molecules of gas could be derived through maximizing a function of entropy, subject to constraints on their energy (Batty M 2004). Recalling the simple Newtonian model, where flow is analogous to force and the attractive effects at two locations are analogous to mass, he demonstrated that there was, in fact, a theoretical basis for its use. Regional scientists of the day must have breathed a collective sigh of relief, for such models were routinely used, and as Bailey (1998) observed, simply because they seemed a sensible and convenient mathematical way to represent spatial interaction. Only ten years prior to Wilson's pioneering efforts the gravity model was recommended to regional science to explain commuting and migration (Roy JR 2004).

Wilson showed that simple Newtonian models of gravity belong to a class of models, which became known as a "family of spatial interaction models" (Fotheringham et al. 2000), each member of which is derived from the principles of statistical mechanics and theoretically justified on the basis of entropy maximization. In short, entropy maximization reflects an enumeration approach to statistics in terms of combinatorial analysis (Roy JR 2004). In its simplest form entropy maximization leads to a model of following general form:

$$T_{ij} = A_i\, B_j\, F_{ij} \qquad (2)$$

where T_{ij} represents the number of trips from origin i to destination j, A_i is the size of origin i, B_j is the size of destination j, and F_{ij} is a function of distance between origin i and destination j. A comparison of (2) with (1) reveals their similarity and illustrates that the Newtonian model is a form of (2) with $F_{ij} = d_{ij}^{-2}$. Sen and Soot (1981) define F_{ij} as a separation factor in a generalized gravity model that encompasses not only distance but also costs, components of travel time, or other measures of separation. However distance is perhaps the most commonly used separation factor for modeling commuting flows.

Equation (2) can be modified to form other models in the same general class with constraints on the origin, destination, or both. Singly constrained models are so called because they are either origin (production)-constrained, or destination (attraction)-constrained. Twice-constrained gravity models are both production and attraction constrained, such that the predicted flows exactly reproduce total observed flows. Estimating a twice-constrained gravity model requires a separate parameter for each origin and destination and the result is purely descriptive rather than offering an explanation for the observed flows. Bailey (2000) demonstrates that for commuting data in Sweden the twice-constrained model, which must be estimated through an iterative process, is not significantly better than the unconstrained model of (2).

The study of spatial interaction as aspatial information processing in the 1980's, and as spatial information processing in the 1990's (Fotheringham et al. 2000) has advanced the field of quantitative geography and regional science. Yet the entropy-derived gravity model still reigns as a tractable framework for an intuitive understanding of observed flows and has been widely used in the social sciences.

Emprical Analysis

Mississippi Work Commuting

In this section we look at commuting flows between counties in Mississippi and examine the relationship that commuting to work has with distance and employment. Our framework is a generalized gravity model and we estimate two sets of parameters: one for commuting in 1990 and another for 2000. The general specification is that of Vermeulen (2003), in which an unconstrained gravity framework forms the basis of estimation of parameters for distance, employment and labor force.

Modeling Framework

Our exposition starts with a gravity model for work commuting in Mississippi in 1990 and 2000:

$$T_{ij} = L_i^{\alpha} E_j^{\beta} d_{ij}^{\gamma} \qquad (3)$$

where T_{ij} is the flow of commuters from the county in which they reside to the county in which they work, i and j, respectively. L_i is the labor force in county i; E_j is the level of employment in county j; d_{ij} is the distance between counties i and j; and α, β, and γ are parameters to be estimated. We expect commuting flows to be roughly proportional to the size of the labor force in the county of residence, and similarly for employment.

Therefore the coefficients α and β should be close to unity. The distance deterrence parameter, δ, we anticipate to be negative to reflect the increasing cost of time with distance.

Data

The data for commuting comes from the U.S. Census Bureau 1990 and 2000 County-to-County Worker Flow files. Labor force and employment data in 1990 are from the U.S. Census Bureau, USA Counties 1998 dataset. Labor force and employment data for 2000 came from the U.S. Census Bureau, County and City Databook 2000. County-level distance data are straight-line great circle estimates based on geographic coordinates from the U.S. Department of Justice, Bureau of Justice Statistics.

Results

We specified a linear form of model (3), which allowed us to use an ordinary least squares estimation procedure (OLS):

$$\ln T_{ij} = \alpha \ln L_i + \beta \ln E_j + \gamma \ln d_{ij} \qquad (4)$$

The first column of Table 3 shows the results of estimating (4) on the 1990 data, while the 2nd column was estimated with 2000 data. All the estimated parameters in both models were statistically significant ($P < 0.0001$). The labor force and employment values were lower than expected, but similar across years. The labor coefficient was higher in 2000 when compared to the coefficients in the 1990 model; the employment coefficient was just opposite with a higher value in 1990 versus the 2000 column. The distance deterrence parameter was, as expected, less than zero and of a greater magnitude in 2000 when compared to the preceding decade's parameter.

Table 3. Parameter Estimates for Models of Work Commuting in Mississippi

	1990	**2000**
Constant	1.3989	2.0846
Labor Force	0.39678	0.40902
Employment	0.58027	0.55195
Distance	-1.8724	-2.0846
N	1598	1856
R^2	0.57	0.60

The labor force and employment coefficients were lower than expected, yet these results are similar to Vermeulen's estimates of commuting in Holland. From 1990 to 2000 the employment coefficient is consistently larger than that for the labor force. This suggests that employment opportunities outside the county affect commuting behavior more than local employment and unemployment combined (since by definition the civilian labor force consists of employed plus unemployed persons). The increase in magnitude of the distance deterrence parameter is also interesting, implying that distance affected commuting more in recent years than in the past. The significance of this finding is that had residents in Mississippi in 2000 been faced with a distance deterrence parameter from the previous decade then the estimated commuting flow would have increased by as much as 142%.

Mississippi Health Commuting

In this section we propose a model of commuting for health care and estimate parameters of a gravity model in a similar fashion as that in the preceding section for work commuting. We start by specifying the variables that we think would be most likely to influence commuting for health care. The specification was based on results from a recent health care survey in Mississippi (Evans G 2004a). In that study respondents' answers to questions in regard to health care access outside their county of residence were grouped into four general categories: convenience, familiarity, necessity, and quality.

We chose to use commuting flows to work as a proxy for convenience, because it was our hypothesis that persons seek health care in the county where they work. Distance was used as a proxy for familiarity, as well as convenience. Necessity we try to explain with per-capita income, the rationale being that higher income allows residents to move more freely. Finally, we used education as a proxy for the quality of health care by assuming that better educated persons would have more discerning preferences, perceptions notwithstanding.

Modeling Framework

The model we used to explore health commuting was similar to that for work commuting, with some differences in specification:

$$H_{ij} = T_{ij}^{\alpha} I_i^{\beta} E_i^{\gamma} d_{ij}^{\delta} \qquad (5)$$

where H_{ij} is the flow of persons from county i, where they reside, to county j where they receive health care. As before, T_{ij} is the flow of workers, and d_{ij} the distance between counties i and j. I_i is average per-capita income in the resident's county i, and E_i is the percentage of educated persons there.

Preliminary findings indicated a high degree of positive correlation between health and commuting flows ($\rho = 0.947$). Therefore we expect the coefficient on worker flows in this model to be positive as well. Furthermore, because of our assumption about convenience, we expect its value to be near unity, because our hypothesis is that people are more likely to seek health care in the county where they work. Parameter estimates of the income and education coefficients were expected to be positive for reasons previously stated. As before, distance should be inversely proportional to the commuting flow.

Data

Health commuting flows are from the Mississippi Hospital Association 2002-2003 Aggregate Patient Origin Study. Worker flows are from the U.S. Census Bureau 2000 County-to-County Worker Flow files. Per-capita income for 2000 is from the U.S. Department of Commerce, Bureau of Economic Analysis. Education data are from the U.S. Census, Profile of Selected Characteristics: percentage of population 25 or older with a bachelor's degree or higher. Distance data were derived from geographic positioning data from the U.S. Department of Justice, Bureau of Justice Statistics.

Results

We estimated (5) using OLS after specifying the following linear form:

$$\ln H_{ij} = \alpha \ln T_{ij} + \beta \ln I_i + \gamma \ln E_i + \delta \ln d_{ij} \qquad (6)$$

with the following results (Table 4). The coefficients on worker flows and per-capita income were statistically significant ($P< 0.05$) but the other parameter estimates were not. Although the coefficient for worker flows was the correct sign, its value was less than expected. The coefficient on per-capita income was negative, an unexpected result that we attempt to later in this paper. Another surprise was that the distance and education coefficients lacked statistical significance.

Table 4. Parameters Estimated in a Gravity Model of Health Commuting

	Parameter Estimates
Constant	6.9783 (0.0088)
Worker Flows	0.43778 (<0.0001)
Per-capita Income	-0.68995 (0.0217)
Distance	0.18129 (0.0738)
Education	-0.2208 (0.1536)
N	1084
R^2	0.31

Values in parentheses are p-values

The coefficient on per-capita income is negative, which implies that increased income leads to lower levels of commuting. Why is this so? Our hypothesis that increased per-capita income allows people to move more freely is evidently incorrect. One explanation might be that persons who have higher levels of income are already located in areas where they feel no need to commute, whereas those individuals who have lower levels of per-capita income live in areas where there is little available health care – they cannot freely move and because of necessity they must commute in order to receive the health care they desire.

Also unexpected was the lack of statistical significance for education and distance. We expected education to explain survey respondent's commuting behavior on the basis of quality. The result implies that quality is not issue, which seems unlikely, and may suggest a misspecification of the variable. Quality, a subjective characteristic, may be difficult to adequately capture in a modeling context such as this.

Distance, as a measure of familiarity, proved also to lack statistical significance, though not nearly as much as education. This may be the result of some degree of multicollinearity, since distance effects, as we showed earlier, are inherent in the workflows variable.

The R^2 values in this and the work commuting models were low, but similar to that seen in similar models (Lowry 1966). This is probably due to the non-linear nature of a model that is estimated after transforming the data.

Conclusions

In this paper we look at work and health-related commuting in Mississippi and explore the relationships between commuting to work, employment, and distance; and those between commuting for health, employment, distance, education, and per-capita income. Our model of health commuting represents a first attempt to relate the "journey-to-health" in Mississippi to key demographic and economic indicators, and opens the door for future research in this area to help understand the behavior of people seeking health care in a state that has been noted as "first in worst" in terms of incidence of obesity, heart disease, diabetes, and infant mortality. Even so, in rural Mississippi health care is not simply a quality-of-life issue – it is often a substantial element of a community's local economy. Statewide, health care contributes more than three billion dollars annually to the rural economy in Mississippi (Evans G 2004b).

By focusing on commuting we emphasize the importance of location. People tend to settle in areas based on residential preferences, yet trade areas are often defined by proximity to a readily available source of labor, thus the two are closely related. It is generally known that industrial manufacturers consider the availability of health care and the quality of educational services prior to making location decisions. These attributes are important in the near term because they are characteristics that people value. In the long term they represent a future source of a well-educated and healthy workers, and a more productive work force.

We have shown in this paper that commuting to work has increased in Mississippi over the past decade, a phenomenon common to all of the southern states, and which has led to urban sprawl. Even in a mostly rural state such as Mississippi this is significant because as Renkow (2004) demonstrates, “a substantial fraction of new jobs within a given county are taken by residents of other counties”. Commuting for health underlines the importance of mobility, perhaps even more so than it does for the journey to work. The model in this paper provides evidence that access to health care is affected by commuting to work. We can only speculate on the effects that changing patterns of mobility will have on health care provision, yet the results definitely suggest there is a relationship.

It may be worthwhile to consider alternative forms of specification of the health commuting model; the lack of statistical significance in the education variable seemed out of place. Perhaps achievement at lower levels of education, a predominant factor in most rural areas, would help to explain health commuting better than a bachelor’s degree. Also a different treatment of distance altogether might be worthwhile to uncover the relationship it seems to have with health commuting. Vermeulen’s model incorporated education into the distance parameter with good effect, indicating a potential non-linear relationship that is not accounted for in our model. It may also be of some benefit to assess different measures of distance. In this paper we used straight line distances, which are at best approximations of the real distance or cost people make to complete the journey to work. Finally, further improvements to the model might also be made if it were once or twice constrained, an obvious extension to the unconstrained model.

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