PARENTAL ATTITUDES TOWARDS CHILDREN WALKING AND BICYCLING TO SCHOOL: A MULTIVARIATE ORDERED RESPONSE ANALYSIS

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ABSTRACT

Recent research suggests that, besides traditional socio-demographic and built environment attributes, the attitudes and perceptions of parents towards walking and bicycling play a crucial role in deciding their children's mode choice to school. However, very little is known about the factors that shape these parental attitudes towards their children actively commuting to school. The current study aims to investigate this unexplored avenue of research and identify the influences on parental attitudes towards their children walking and bicycling to school, as part of a larger nationwide effort to make children more physically active and combat rising trends of childhood obesity in the US. Through the use of a multivariate ordered response model (a model structure that allows different attitudes to be correlated), the current study analyses five different parental attitudes towards their children walking and bicycling to school, based on data drawn from the California add-on sample of the 2009 National Household Travel Survey. In particular, the subsample from the Los Angeles – Riverside – Orange County area is used in this study to take advantage of a rich set of micro-accessibility measures that are available for this region. It is found that school accessibility, work patterns, current mode use in the household, and socio-demographic characteristics shape parental attitudes towards children walking and bicycling to school. The study findings provide insights on policies, strategies, and campaigns that may help shift parental attitudes to be more favourable towards their children walking and bicycling to school.

1. INTRODUCTION

In recent years, there has been an alarming increase in the rate of obesity among children in the United States. The latest statistics suggest that nearly one in five school-aged children is obese, a rate that has tripled from just 30 years ago (*1*, *2*). Since obesity rates are being tied to inactive sedentary lifestyles, there is a vast body of literature at the interface of transportation and public health that is concerned with identifying and quantifying the influence of various factors on levels of physical activity and the use of active modes of transportation – namely, walking and bicycling (*3-5*). Despite the potential benefits associated with using non-motorized modes of transportation for travel to and from school, these modes have experienced a dramatic decline in mode share over the past 40 years. Whereas in 1969, nearly one half of all school trips were made by walking or bicycling, by 2009, that share had dropped to under 15 percent (*6*).

There is a vast body of literature that identifies and quantifies the influence of demographic, built environment, and socio-economic characteristics on school mode choice. Among demographic variables, the child's age (*7*, *8*), gender (*9*, *10*), and ethnicity/race (*11*, *12*) have been found to significantly impact children's school mode choice. In general, it is found that older children and boys are more likely to walk or bicycle to school than other children. In the issue of race, papers present conflicting results, with some studies attributing this difference to underlying factors such as household socio-economic status and residential location (*11*). Others suggest that these differences could be the result of cultural variations in attitudes and perceptions among parents of different ethnicities (*9*). Finally, built environment attributes and accessibility variables are also important determinants of children's school mode choice. Distance to school is one of the most notable variables influencing the choice to use non-motorized modes of transportation (*13*, *14*). There is a growing body of evidence that parental attitudes and opinions are also critical determinants of children's school travel mode. In a Southern California based study, McMillan (*9*) finds that attitudes and perceptions of parents regarding the safety and traffic situation of the neighbourhood, as well as certain social norms, were more important in influencing school travel mode choice than built environment attributes. Children with parents who had greater concerns about traffic conditions or neighbourhood safety were less likely to walk or bike to school. Timperio *et al.* (*7*) found that parental perceptions of the neighbourhood are more strongly related to children's mode choice behaviour than the child's own perceptions of the neighbourhood. Zhu and Lee (*15*) report similar findings noting that parent's perceptions of barriers were greater deterrents to walking and bicycling than children's perceptions of barriers to the use of such modes. They find that a child is four times more likely to walk if the parent perceived the distance to be close enough for the child to walk. Their study, as well as that of Wen *et al.* (*16*), showed that actual experience with the non-motorized modes of transportation influences parental attitudes and perceptions of the built environment and neighborhood safety. Parents of children who walked regularly to school perceived the built environment and neighbourhood to be less dangerous than parents whose children did not walk or bicycle to school.

Despite studies that show the clear importance of parental attitudes and perceptions towards bicycling and walking in the choice of mode for school travel, there is a dearth of research on identifying and quantifying the influence of various factors on attitudes and perceptions. In the case of school-going children, parents are likely to play a strong decision-making role when it comes to mode choice for school-related travel. As such, insights into the factors that shape parental attitudes and perceptions towards their children walking and bicycling to school would greatly aid professionals in designing policies, campaigns, and built

environments that would help promote the use of these modes. A few studies provide initial indications of the types of factors that are likely to influence parental attitudes and perceptions. Timperio *et al.* (*7*) note that the age of the child and household socio-economic status influence parental attitudes and perceptions. Johansson (*17*), who looks broadly at children's leisure travel, finds that parents of older children adopt a more positive attitude toward independent travel than parents of younger children. Parents in households with higher levels of car ownership were found to be more inclined towards chauffeuring children by car, and less inclined towards supporting independent travel by the child.

This paper is motivated by previous work that suggests the presence of strong associations between attitudes and travel behaviour (see van Acker *et al.* (*18*)). Theoretical frameworks describing the underlying reasons for and nature of the associations between attitudes and behaviour are offered by Azjen and Fishbein (*19*). van Acker *et al.* (*18*) develop a model, based on frameworks presented by Azjen and Fishbein, that includes a spatial component and a socio-economic component from the theories of transport geography, and a personality component from the theories in social psychology. In this context, this paper aims to shed additional light on parental attitudes and perceptions towards bicycling and walking as modes of transportation for children's school travel. The paper provides a more comprehensive examination of the factors that shape parental attitudes and perceptions towards these modes by simultaneously considering five different attitudinal variables in a joint model system. Each attitudinal variable is an ordered response variable with the response indicating the extent to which the factor is considered by the parent as an issue in their children walking or bicycling to school. A multivariate ordered response model is formulated and applied in this paper to account for the presence of possible correlations among unobserved attributes that simultaneously affect different attitudinal variables. The model system is estimated on a subsample of the California add-on of the 2009 National Household Travel Survey which included a series of questions on parental attitudes towards children's bicycling and walking to and from school. In particular, the subsample from the Southern California region covered by the Los Angeles – Riverside – Orange County CMSA (consolidated metropolitan statistical area) is chosen because of the availability of a rich set of micro-accessibility measures that can be included in the model specification.

It must also be noted here, that one of the key hypotheses that motivated this study was that parents of children who regularly walked or biked were less likely to be concerned about the various factors that served as deterrents to the use of non-motorized modes of transportation. It was postulated that such parents are likely to be more aware of the built environment and their children's navigational abilities, than parents whose children did not walk or bicycle as much. In the absence of information, the latter group is more likely to develop an exaggerated sense of danger associated with the use of non-motorized modes, and is thus less likely to permit their children to walk or bicycle to school.

The remainder of this paper is organized as follows. The second section presents the modelling methodology adopted in this paper. The third section describes the data used in this study and presents descriptive statistics of the sample. The fourth section presents model estimation results. Finally, the fifth section offers conclusions and a discussion of the policy implications of the results.

2. MODELING METHODOLOGY

A multivariate ordered-response modeling structure is used for the current study. The modeling framework assumes the presence of an underlying set of multivariate continuous latent variables whose horizontal partitioning maps into the observed set of ordered outcomes (in the current empirical context this would be the degree to which a parent considers a certain factor to be an issue in children walking or bicycling to school). Such an ordered-response system allows the use of a general covariance matrix for the underlying latent variables, which translates to a flexible correlation pattern among the observed ordered outcomes. While there have been numerous applications of the univariate ordered response model in previous transportation literature, the application of multivariate ordered response models (MORM), especially for more than three ordered outcome variables, are extremely rare. Bhat *et al.* (*20*) provide a summary of the literature in this area and propose the use of the Composite Marginal Likelihood (CML) approach to estimate a MORM. Since the CML uses a simple estimation technique and requires no simulation machinery, while producing consistent and unbiased results, the CML approach is used in this study to estimate model parameters. The remainder of this section presents a brief overview of the formulation.

Let q be an index for individuals (q = 1, 2, …, Q), and let i be the index for attitudinal variable (i = 1, 2, …, I) where I denotes the total number of attitudinal variables for each individual (in the current study, I = 5). Let the number of response values for attitudinal variable i be K_i (*i.e.*, the discrete levels, indexed by k, belong in $\{1, 2, \ldots, K_i\}$ for variable i). In the usual ordered response framework notation, the latent propensity (y_{qi}^*) for each attitudinal category is written as a function of relevant covariates and related to the observed ordered outcome (y_{qi}) through threshold bounds (*21*, *22*):

$$y_{qi}^* = \beta_i' x_{qi} + \varepsilon_{qi}, y_{qi} = k \text{ if } \theta_i^{k-1} < y_{qi}^* < \theta_i^k, \quad (1)$$

where x_{qi} is a ($L \times 1$) vector of exogenous variables (not including a constant), β_i is a corresponding ($L \times 1$) vector of coefficients to be estimated, ε_{qi} is a standard normal error term, and θ_i^k is the upper bound threshold for ordered response level k of attitudinal category i ($\theta_i^0 < \theta_i^1 < \theta_i^2 \ldots < \theta_i^{K_i}$; $\theta_i^0 = -\infty$, $\theta_i^{K_i} = +\infty$ for each category i). The threshold bounds define a range of the underlying latent continuous variable corresponding to each observed discrete outcome. The ε_{qi} terms are assumed independent and identical across individuals (for each and all i). For identification reasons, the variance of each ε_{qi} term is normalized to 1. However, the model allows correlation in the ε_{qi} terms across attitudinal variables i for each individual q. If $\varepsilon_q = (\varepsilon_{q1}, \varepsilon_{q2}, \varepsilon_{q3}, \ldots, \varepsilon_{qI})'$, then ε_q is multivariate normal distributed with a mean vector of zeros and a correlation matrix as follows:

$$\varepsilon_q \sim N\left[\begin{pmatrix}0\\0\\\vdots\\0\end{pmatrix}, \begin{pmatrix}1 & \rho_{12} & \rho_{13} & \cdots & \rho_{1I}\\ \rho_{21} & 1 & \rho_{23} & \cdots & \rho_{2I}\\ \vdots & \vdots & \vdots & \ddots & \vdots\\ \rho_{I1} & \rho_{I2} & \rho_{I3} & \cdots & 1\end{pmatrix}\right], \text{ or } \quad \varepsilon_q \sim N[\mathbf{0}, \mathbf{\Sigma}] \quad (2)$$

The off-diagonal terms of Σ capture the error covariance across the underlying latent continuous variables of the different attitudinal variables. In other words, they capture the effects of common unobserved factors influencing the propensity of ordered response levels for each attitudinal variable. Thus, if ρ_{12} is positive, it implies that individuals with a higher than average propensity to cite the first attitudinal variable as an issue are also likely to have a higher than average propensity to cite the second attitudinal variable as an issue. As a special case, if all the correlation parameters (*i.e.*, off-diagonal elements of Σ stacked into a vertical vector Ω), are zero, the model system in Equation (1) collapses to a set of independent ordered response probit models.

The parameter vector of the multivariate ordered probit model is $\delta = (\beta_1', \beta_2', ..., \beta_I';\ \theta_1', \theta_2', ..., \theta_I';\ \Omega')'$, where $\theta_i = (\theta_i^1, \theta_i^2, ..., \theta_i^{K_i-1})'$ for $i = 1, 2, ..., I$. Let the actual observed ordered response level for individual q and attitudinal variable i be m_{qi}. Then, the likelihood function for individual q may be written as follows:

$$L_q(\delta) = \Pr(y_{q1} = m_{q1}, y_{q2} = m_{q2}, ..., y_{qI} = m_{qI})$$

i.e.,

$$L_q(\delta) = \int_{v_1=\theta_1^{m_{q1}-1}-\beta_1'x_{q1}}^{\theta_1^{m_{q1}}-\beta_1'x_{q1}} \int_{v_2=\theta_2^{m_{q2}-1}-\beta_2'x_{q2}}^{\theta_2^{m_{q2}}-\beta_2'x_{q2}} \cdots \int_{v_I=\theta_I^{m_{qI}-1}-\beta_I'x_{qI}}^{\theta_I^{m_{qI}}-\beta_I'x_{qI}} \phi_I(v_1, v_2, ..., v_I \mid \Omega) dv_1 dv_2 ... dv_I \quad (3)$$

The likelihood function above requires the computation of an *I*-dimensional rectangular integral. The evaluation of such multidimensional normal integrals can be problematic even for moderate sizes of *I* in terms of computational effort. Further, such simulation methods do get imprecise as the number of dimensions increases, leading to convergence problems during estimation. For these reasons, this paper employs a pairwise marginal likelihood estimation approach, which corresponds to a composite marginal approach based on bivariate margins (see Apanasovich (*23*) and Bhat *et al.* (*20*) for the use of the pairwise likelihood approach). The pairwise marginal likelihood function for individual q may be written as follows:

$$L_{CML,q}(\delta) = \prod_{i=1}^{I-1} \prod_{g=i+1}^{I} \Pr(y_{qi} = m_{qi}, y_{qg} = m_{qg})$$

$$= \prod_{i=1}^{I-1} \prod_{g=i+1}^{I} \left[\begin{array}{l} \Phi_2\left(\theta_i^{m_{qi}+1} - \beta_i'x_{qi}, \theta_g^{m_{qg}+1} - \beta_g'x_{qg}, \rho_{ig}\right) - \Phi_2\left(\theta_i^{m_{qi}+1} - \beta_i'x_{qi}, \theta_g^{m_{qg}} - \beta_g'x_{qg}, \rho_{ig}\right) \\ -\Phi_2\left(\theta_i^{m_{qi}} - \beta_i'x_{qi}, \theta_g^{m_{qg}+1} - \beta_g'x_{qg}, \rho_{ig}\right) + \Phi_2\left(\theta_i^{m_{qi}} - \beta_i'x_{qi}, \theta_g^{m_{qg}} - \beta_g'x_{qg}, \rho_{ig}\right) \end{array} \right], \quad (4)$$

and $L_{CML}(\delta) = \prod_q L_{CML,q}(\delta)$

The pairwise likelihood function above is easily maximized, and the effort involved is no more difficult than in a usual bivariate ordered probit model. The pairwise estimator $\hat{\delta}_{CML}$ obtained by maximizing the logarithm of the function in Equation (4) with respect to the vector δ is consistent and asymptotically normal distributed. Additional inference details of the pairwise estimator are provided in Bhat *et al.* (*20*).

3. DATA DESCRIPTION

In this study, the Southern California portion of the California add-on sample from the recent 2009 National Household Travel Survey (NHTS) is used. This particular sample is used because the California add-on survey included a series of questions on the attitudes of adults towards their own bicycling and walking patterns, as well as a series of questions on the attitudes of parents towards their children walking and bicycling to school. The subsample from the Southern California region resides in the Los Angeles – Riverside – Orange County consolidated metropolitan statistical area (CMSA) and has been selected for analysis because a rich set of micro-accessibility measures that describes the built environment is available for this geographical area.

Descriptive statistics for the sample used in the analysis of this paper are presented in Table 1. After extensive data cleaning and filtering, the final sample available for analysis included 1000 respondents. Note that only one parent in each household answered these attitudinal questions for one randomly chosen school-aged child. Auto availability is high with only two percent of households indicating zero car ownership. Nearly one-half of the households fall into the highest income category (out of the three categories that are used in this paper) of $80,000 and above, suggesting that the sample used for analysis in this paper is relatively affluent. As expected, household size distribution is skewed towards larger households as the sample chosen for analysis includes only those households that have at least one child. A vast majority of the households reside in an urban area (as defined by the urban/rural classifications in Census 2000). A majority of children are found to travel to and from school by car. However, the percentage of children bicycling or walking to school is about 21 percent, which is higher than the national average of 13 percent (*24*). About 38 percent of the children reside less than one mile from the school location; about an equal percent reside more than two miles from school. While the former group is a candidate for walking and bicycling to school, the use of such modes is likely to be a challenge for the latter group (*13*). About 15 percent of the children attend private school, which is another indicator that the sample is relatively affluent. The parents in the sample are rather well-educated with about 70 percent of fathers and mothers indicating their education level as “some college or above”. Among fathers, 87 percent are workers, whereas the corresponding percentage for mothers is lower at just under 60 percent. In households with both a father and mother, 54 percent indicated that both parents are workers. Thirty percent of these households listed both parents as working full time. It is likely that these latter households in particular face time-space constraints associated with work schedules and locations that affect their children’s activity-travel patterns and mode choices.

The parents were asked to describe the level of concern they have about the dangers and difficulties their children might face while walking or bicycling to school. Responses to these questions constituted the dependent variables in this study. More specifically, the five inter-related dependent variables in this study are the responses that parents gave when they were asked to indicate the extent to which each of the following items is an issue in the context of their children bicycling or walking to school:

- The distance between home and school
- Violence or crime along the route to school
- The speed of traffic along the route to school
- The amount of traffic along the route to school
- Poor weather or climate in the area

The response scale ranged from 1 to 5, with a response of 1 indicating that the item was not considered an issue, and a 5 indicating that the item was considered as a serious issue or deterrent to the parent allowing the child to bicycle or walk to and from school. Table 1 also presents the distribution of responses provided by parents to these five attitudinal variables. Among the five attitudinal factors considered in this paper, the three factors that were most cited as being serious issues were the volume of traffic, speed of traffic, and distance to school (in that order). About 30 percent of the parents considered these three items to be serious issues that acted as deterrents to their children walking and bicycling to school. About 60 percent of the parents considered weather to not be an issue, generally reflecting the favorable weather conditions in the Southern California region. About 44 percent of the parents considered crime not to be an issue. This statistic may be reflective of the larger share of high income households (recall that nearly one in two households fell into the highest income category used in this study) who are likely to be residing in safer and more affluent neighborhoods. However, perceptions of personal safety are important as evidenced by the nearly 20 percent of parents who considered crime to be very much an issue or a serious issue when it comes to their children walking or bicycling to school.

The analysis for this paper considered a host of explanatory variables that might affect parental attitudes towards their children bicycling and walking to and from school. Explanatory variables could be broadly classified into five categories representing school attributes, children's attributes, parent's attributes, household attributes, and built environment attributes. Built environment attributes included a host of accessibility variables that measured both transportation access and destination opportunities. Accessibility measures included, for example, the total network length that a household could access within 10 minutes (by driving a car at 30 mph) of the residential location. Destination opportunity based measures captured the number of employees by industry type that could be accessed within various travel time buffers (10 minutes, 20 minutes, and 50 minutes). Accessibility measures were developed for a total of 15 industry types. Additional details on the formulation and development of these measures may be found in Chen *et al.* (*25*).

4. MODEL ESTIMATION RESULTS

This section presents a detailed discussion of the model estimation results. One of the key hypotheses that motivated this study was that as children walked or bicycled more, parents were less likely to be concerned about various factors that served as deterrents to the use of non-motorized modes of transportation. It was postulated that such parents are likely to be more aware of the actual walking and bicycling conditions and more confident about their children's ability to safely navigate the built environment, than parents whose children did not walk or bicycle as much. The latter group, in the absence of information about the actual walking and bicycling environment and their children's navigation abilities, are more likely to have an exaggerated sense of danger associated with bicycling and walking. This in turn will make them less likely to permit their children to walk or bicycle to school. Model estimation results (as will be discussed in this section) generally confirmed that this hypothesis cannot be rejected. Therefore understanding the influences behind these parental attitudes is very important, as such an understanding would be crucial in the design of policies, campaigns, and built environments that help shift the attitudes towards bicycling and walking to be more positive.

The remainder of this section provides a discussion of the results organized according to the set of explanatory variables under consideration. The multivariate ordered response model

system estimated in this paper includes a set of five equations, one for each attitudinal variable. Complete model estimation results are presented in Table 2. As the focus of the analysis was exclusively on the extraction of behavioral relationships (as opposed to forecasting applications), it was considered sufficient to perform model estimation on the unweighted survey sample. Given the nature of the model form and specification, the relationships found in this analysis may be considered representative of the nature of the influences of various attributes on parental attitudes. Most of the model coefficients are statistically significant at the 0.05 level (these are the estimates with no superscript identifiers). A few variables are, however, not statistically significant even at the 0.1 level; these variables have been retained in the model specification for their intuitively appealing behavioral interpretation.

4.1 Effect of School Attributes on Parental Attitudes

The first set of variables presented in Table 2 pertains to school attributes, namely distance to school and whether the school is a public or private school. As expected, when the distance to school is less than a quarter-mile, parents are less likely to consider weather or the distance to school to be issues or impediments to walking or bicycling to school. As distance increases, one notices that the coefficients show an increasing trend for the variable representing distance to school, signifying that parents consider distance to school to be an increasingly serious issue as the actual distance of the school from their home increases. When the distance is over two miles, parents also consider speed and volume of traffic to be major issues (as evidenced by the positive coefficients of 0.303 and 0.390). The findings here are quite consistent with those reported in the literature concerning the adverse effect of distance on the bicycle or walk mode shares to school (*13*, *15*). However, crime was considered less of an issue in the context of school distance being greater than two miles. This counter-intuitive result merits further investigation, but it is possible that when the distance is greater than two miles, other considerations (such as traffic) become more serious issues than crime, thus resulting in the negative coefficient for this variable. It is found that parents of children going to private schools are quite sensitive to crime, and the speed and volume of traffic. It is possible that private schools are located farther away from the home location, thus raising concerns on these factors. As private school children tend to be more car dependent (*26*, *27*), it is also possible that the lack of first-hand knowledge of the walking and bicycling environment may result in parents being more concerned about these factors than parents whose children have experienced the built environment for themselves. The greater level of car dependence among private school children (and the resulting absence of exposure to weather) may explain why parents of private school children are less concerned about the weather.

4.2 Effect of Children's Attributes on Parental Attitudes

As expected, children's age and gender, as well as their current levels of bicycling and walking influence their parent's attitudes towards them walking or bicycling to school. As the age of the child increases, parents are less likely to consider the speed of traffic and the distance to school to be serious issues associated with walking or bicycling to school. This is intuitive as parents are likely to consider older children as more independent and mature, and thus capable of navigating the path to and from school safely. These findings are consistent with those reported earlier by Timperio *et al.* (*7*), Alton *et al.* (*8*), and Johansson (*17*), all of whom note that age is a significant variable associated with children's mode choice and independent travel.

Parents of boys are less likely to be concerned about crime, speed of traffic, and distance to school. It appears that parents consider boys to be less vulnerable to crime and more able to handle longer distances and higher-speed traffic environments. In general, this finding is consistent with expectation and there is evidence in the literature to support these results. Studies by Prezza *et al.* (*10*), McMillan (*9*), and McDonald (*28*) indicate that boys are generally allowed more to travel independently than girls. On the other hand, there are a few studies (*e.g.*, Alton *et al.* (*8*) and Johansson (*17*)) that found no significant gender differences in independent travel to and from school. The results in this paper appear to suggest that gender does play a role in how parents view the ability of the child to travel independently to and from school. This in turn is likely to impact mode choice as evidenced in a review by Sirard and Slater (*29*) that finds parental evaluation of a child's navigational abilities to be a big influence on mode choice decisions.

Parents of children who currently bicycle and walk regularly are less concerned about crime and distance to school. As these children have already shown that they can safely navigate the built environment and travel independently by bicycling and walking, it is not surprising that parents of these children consider issues of crime and distance to be less serious than other parents. Moreover, these parents are likely to be more aware of the actual walking and bicycling conditions and the greater level of awareness may help ameliorate concerns about crime, safety, and the abilities of their children. These findings are consistent with results reported earlier by Cooper *et al.* (*30*, *31*) that suggest children who walked or biked to school were overall more physically active than their counterparts who travelled to school by motorized transport. Information campaigns aimed at providing better information about crime and safety in neighborhoods may help shift parental attitudes positively towards their children bicycling and walking to and from school.

4.3 Effect of Household Attributes on Parental Attitudes

With respect to the role of household attributes in shaping parental attitudes, parents in higher income households generally had lower levels of concern about crime and weather. It is possible that these households live in safer, more affluent neighborhoods where crime is not an over-riding concern in the context of bicycling or walking to school. In addition, these households are likely to be more auto-oriented (suburban, higher car ownership households), and hence there may be a lower level of sensitivity to weather for parents in these households. It is interesting to note that car ownership itself did not prove to be significant in explaining parental attitudes towards bicycling and walking. One reason for this may be that virtually all households have at least one car, thus making car ownership a non-issue in terms of its influence on parental attitudes towards bicycling and walking. In a region such as Southern California, where car ownership is quite universal, it is reasonable to expect car ownership to play virtually no role in shaping attitudes about walking and bicycling. Perhaps an effect would have been observed had there been a sizable number of households with no cars.

A variety of race and ethnicity variables affected parental attitudes towards walking and bicycling. There was no discernible pattern, but the fact that several race variables entered the model specification and were statistically significant suggests that there are potential socio-demographic and cultural differences across racial groups that affect parental attitudes towards bicycling and walking. As noted by McDonald (*11*), it is possible that racial differences are observed due to other underlying reasons, with the race variables simply acting as proxies to capture such effects. As the number of workers in a household increased, parents tended to be

more sensitive to crime, although the coefficient is statistically insignificant. It is not clear why this may be the case, but there may be a heightened sense of concern for the safety of children among parents in households where the adults are all working outside the home. Parents in households of larger size and who are renting their residence are more prone to considering distance to school as an issue that deters walking and bicycling to school, perhaps because these households live farther from the school location.

4.4 Effect of Parent's Attributes on Their Own Attitudes

This section offers a discussion of how the characteristics of the parents themselves impact their attitudes towards walking and bicycling. If the father uses public transit, then the parents are less likely to be concerned about crime, volume of traffic, and distance to school. The greater level of awareness and knowledge of the environment that comes from public transit use potentially contributes to this lower level of concern. On the other hand, when the mother uses public transit, there is a heightened sensitivity to crime (though this variable is statistically insignificant).When at least one parent uses public transit, the results show a greater concern for weather. Similarly, it is found that, as the time spent by the father or mother walking or bicycling increases, there is greater level of concern related to speed of traffic. In other words, it appears that level of awareness and experience in using the built environment for walking and bicycling may work both ways. In the case of crime, volume of traffic, and distance to school, the sensitivity is lowered, but in the case of weather and speed of traffic, the sensitivity is heightened. These findings are quite intuitive and consistent with expectations. The frequency of walk and bike trips on the part of the mother lowers concerns regarding distance to school, once again suggesting that familiarity and knowledge of the built environment may lower concerns related to distance. The use of alternative modes of transportation for work travel on the part of the parents specifically lowers concerns related to volume of traffic. If the father or mother uses transit, bicycles, or walks to work, then it is likely that they have a greater level of knowledge and awareness of actual traffic conditions and this knowledge, in turn, lowers the level of sensitivity associated with traffic volumes.

With respect to educational attainment of the parents, higher levels of education for the mother were associated with greater levels of sensitivity and concern for virtually all attitudinal variables except weather. It appears that parents in such households tend to amplify the level of concern associated with various deterrents to walking and bicycling to school, although it is not exactly clear why that might be the case.

The work arrangements of the parents play a key role in shaping their attitudes towards bicycling and walking as modes of transportation to and from school. In general, it is found that greater levels of flexibility associated with work arrangements and schedules lowers the level of concern or sensitivity with respect to various attitudinal measures including crime, weather, distance, and volume of traffic. It is likely that parents who have flexible work arrangements and schedules feel more confident that they can be available for the child and respond to emergency situations in a very timely manner. In addition, parents who have flexible work arrangements and schedules are more likely to be able to walk or bike with their children to and from school, thus lowering concerns about personal safety, distance, and traffic conditions. On the other hand, parents who have rigid work timings are more likely to chauffer their children to and from school because of schedule constraints. This finding is consistent with that reported by Yarlagadda and Srinivasan (*32*) who found that mothers with fixed work schedules were more likely to drive their children to school than mothers with flexible work schedules. Similarly, Zhu and Lee (*15*)

found that children of parents who thought "walking their kids to school required too much planning" were less likely to walk or bicycle to school, presumably because these parents were just too time-constrained to undertake such planning. This is further supported by the finding in this paper that a father's need to arrive at work in the morning (rigidity in work schedule) heightens the level of concern associated with distance to school. From a policy standpoint, it appears that providing parents flexible work arrangements could have a positive impact on their attitudes regarding children bicycling or walking to and from school. It is not entirely clear why parents in households where both parents work full time consider speed of traffic and volume of traffic to be of less concern than other parents. This finding merits further investigation; it may be that these parents consider crime and distance to be greater deterrents to walking and bicycling than traffic conditions.

4.5 Effect of Built Environment Attributes on Parental Attitudes

The final set of variables included in the model system represents the built environment. A host of variables were considered, but only a few eventually made their way into the final model. As the length of primary arterials accessible to the household increases, the parents tend to be more sensitive to crime. As areas with greater street access and density are perceived to have higher crime rates as evidenced in studies by Harries (*33*) and Foster and Giles-Corti (*34*), it is reasonable to expect parents to be more worried about personal safety for their children. Parents in households that have greater levels of access to freeways are found to be less sensitive to weather and traffic speed considerations. As expected, parents in households in a non-urban location consider volume of traffic to be less of an issue than parents in households located in an urban location. This is presumably due to the lower levels of traffic volumes in non-urban locations that naturally lead to lower levels of concern for this attitudinal measure. An interesting finding is that none of the built environment measures affected parental attitudes related to distance to school. For example, one could hypothesize that higher levels of access and street connectivity could potentially lead to lower levels of concern about distance. However, no such effects were found in this study. Further research is needed to explore how micro-accessibility measures formulated at different spatial scales affect parental attitudes towards their children's mode choice to school.

4.6 Error Correlation Matrix and Data Fit

The use of the multivariate ordered response model formulation allows the estimation of correlations between the unobserved error components of the five attitudinal dependent variables considered in this paper. Information about correlations across error terms provides valuable insights on how different attitudinal variables are related to one another, and how policies addressed at affecting one attitudinal measure might have an impact on other attitudinal measures. The estimated error correlations are shown in Table 2.

As expected, unobserved error terms associated with attitude towards volume of traffic and attitude towards speed of traffic are highly positively correlated. This finding suggests that measures to reduce speed such as implementation of traffic calming devices would not only lessen a parent's anxiety about the speed of traffic, it would also make them less worried about the volume of traffic that their child has to encounter. This correlation of attitudes is natural given that both of these attitudes measure perspectives on traffic conditions.

The error term associated with distance is found to be positively correlated with both volume and speed of traffic. Again, this is consistent with expectations as concerns about

distance are likely to be related to concerns about exposure to traffic, as the likelihood of coming across bad traffic conditions increases with distance. In other words, it appears important to consider having good schools within or in close proximity to residential neighborhoods. By reducing the distance between home and school, one is not only reducing concerns about distance, but also reducing concerns about volume and speed of traffic to which the child would be exposed. Other unobserved error components show moderate positive correlations.

The estimated multivariate model is evaluated by comparing the model with a restricted model, which corresponds to independent ordered response estimations for each of the five attitudinal variables. The two models may be compared using the adjusted composite likelihood ratio test (ADCLRT) test (see Pace *et al.* (*35*) and Bhat (*36*) for details). This statistic has a chi-squared asymptotic distribution with 10 degree of freedom. The statistic is 368.9, which is higher than the corresponding critical chi-squared value with ten degree of freedom at any reasonable level of significance. This indicates the clear data fit superiority of the multivariate model estimated here, and indicates that unobserved factors have the same direction of effect on the different parental attitude variables regarding their children walking/bicycling to school.

5. CONCLUSIONS

This paper aims to examine the factors that influence parental attitudes towards their children walking or bicycling to school, in the context of a larger effort to make children more physically active and combat rising trends in childhood obesity. As parents tend to be the primary decision-makers with respect to children's mode choice, it is critical to understand the factors that shape their attitudes. Using data from the California add-on sample of the 2009 National Household Travel Survey of the United States, a multivariate ordered response model was estimated using the composite marginal likelihood approach. The data set included information on five attitudinal variables representing the extent to which parents considered different factors as deterrents or issues in the context of their children walking or bicycling to school. The five attitudinal measures were related to crime, weather, volume of traffic, speed of traffic, and distance to school. The multivariate ordered response model formulation accommodates error correlations across equations in the model system. Model estimation results show that there are significant error correlations and that the goodness-of-fit of the joint model is statistically superior to that of the independent model system that ignores error correlations. These findings illustrate the importance of using a multivariate model system in the empirical context considered in this paper.

It is found that a host of variables affect parental attitudes towards their children walking or bicycling to school. These results have important policy implications. First, proximity of schools to residential neighborhoods is critical to shaping favorable parental attitudes towards walking and bicycling. Cities, counties, and school districts should consider how best to size and position a school relative to surrounding residential neighborhoods so that it is feasible for children to bicycle and walk to school. Second, schools and communities should institute programs that help bring about awareness and knowledge of the walking and bicycling environment among both parents and children. Organizing "Walk to School" days can help bring about this awareness as parents and children would feel obligated to walk to school on such days and experience the environment first-hand. In order to motivate children even more, schools can set up an incentive based program, where at the end of a specific time period the child who has walked or bicycled the most can win some small token prize (*37*). Schools should also hold regular safety demonstrations that will help children become safe pedestrians or cyclists. These demonstrations can help to quell some parental concerns about the dangers of active commuting

and promote more independent travel by the children. Another way of alleviating parental fears is by instituting special programs such as the "Walking Bus" where a group of children from a neighborhood walk or bicycle to school together with an adult escort (*37*, *38*). The adult escorts are usually the parents of the children and they are set up on a rotating routine. By taking turns to escort the children, the parents get to save time, while still ensuring that their child is accompanied by an adult on their way to school. Third, there should be a concerted effort to enhance flexibility in the work place for parents. It is found that parents with greater levels of work flexibility are less concerned about various issues related to their children bicycling or walking to school. They are likely to be more favorable to the use of non-motorized modes of transportation, because they are presumably less time constrained (and therefore have the time to walk or bicycle with their child to school) and are more confident that they can respond to any emergency situation.

A key finding of this paper is that error terms associated with different attitudinal variables are correlated with one another. Correlations were strongest between speed and volume of traffic, distance and traffic variables, and between crime and traffic variables. In general, this suggests that transportation engineers can design built environments that simultaneously ease multiple parental concerns about their children walking or bicycling to school. For example, traffic calming measures may help alleviate concerns related to both speed and volume of traffic. Grid street patterns that reduce travel distances (by providing direct connectivity between home and school, and eliminating the need for the child to walk along busy arterials) may ease concerns about distance to school, and volume and speed of traffic. In turn, these designs would also reduce concerns about crime. Thus, a series of urban design strategies can help shift parental attitudes favorably towards walking and bicycling for their children.

Future efforts in this arena should be aimed at further enhancing the measurement of built environment attributes (accessibility measures) and modeling their impact on parental attitudes towards bicycling and walking. In this study, only a very limited influence of accessibility measures was found. Additional secondary variables on crime statistics, traffic patterns, and street connectivity would prove useful in better understanding how these factors affect attitudes. In addition, further research needs to be conducted to better understand the direction of relationships between attitudes, contextual attributes, and choice behaviors of interest. Future efforts should also attempt to control for self-selection effects that may be at play, where people are inclined to locate themselves in environments consistent with their modal preferences. Another potential issue that might warrant attention is the exploration of the extent to which responses to attitudinal questions in the survey are conditioned by behavioral choices. For example, a parent whose child walks to school may be inclined to say that it is a safe neighborhood to justify the choice of letting his or her child walk to school (regardless of the true safety record of the neighborhood). Finally, data about children's attitudes towards bicycling and walking should be collected and analyzed to see how their own attitudes are shaped by various factors, and in turn influence choice behaviors.

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REFERENCES

1. CDC. The Obesity Epidemic and United States Students. Centers for Disease Control and Prevention, Division of Adolescent and School Health, Atlanta, GA, 2011. Available at: http://www.cdc.gov/healthyyouth/yrbs/pdf/us_obesity_combo.pdf, accessed July 25, 2011.
2. Ogden, C., and M. Carroll. Prevalence of Obesity among Children and Adolescents: United States, Trends 1963–1965 through 2007–2008. Centers for Disease Control and Prevention, National Center for Health Statistics, 2010. Available at: http://www.cdc.gov/nchs/data/hestat/obesity_child_07_08/obesity_child_07_08.pdf, accessed July 25, 2011.
3. Handy, S.L., M.G. Boarnet, R. Ewing, and R.E. Killingsworth. How the Built Environment Affects Physical Activity: Views from Urban Planning. *American Journal of Preventive Medicine*, Vol. 23, No. 2, 2002, pp. 64-73.
4. Frank, L.D., M.A. Andresen, and T.L. Schmid. Obesity Relationships with Community Design, Physical Activity, and Time Spent in Cars. *American Journal of Preventive Medicine*, Vol. 27, No. 2, 2004, pp. 87-96.
5. Badland, H., and G. Schofield. Transport, Urban Design, and Physical Activity: An Evidence-Based Update. *Transportation Research Part D*, Vol. 10, No. 3, 2005, pp. 177-196.
6. National Safe Routes to School Task Force. Safe Routes to School: A Transportation Legacy. A National Strategy to Increase Safety and Physical Activity among American Youth. Report to the US Department of Transportation and US Congress, 2008. Available at: http://www.saferoutesinfo.org/sites/default/files/task_force_report.web_.pdf, accessed July 25, 2011.
7. Timperio, A., D. Crawford, A. Telford, and J. Salmon. Perceptions About the Local Neighborhood and Walking and Cycling Among Children. *Preventive Medicine*, Vol. 38, No. 1, 2004, pp. 39-47.
8. Alton, D., P. Adab, L. Roberts, and T. Barrett. Relationship Between Walking Levels and Perceptions of the Local Neighbourhood Environment. *Archives of Disease in Childhood*, Vol. 92, No. 1, 2007, pp. 29-33.
9. McMillan, T.E. The Relative Influence of Urban Form on a Child's Travel Mode to School. *Transportation Research Part A*, Vol. 41, No. 1, 2007, pp. 69-79.
10. Prezza, M., S. Pilloni, C. Morabito, C. Sersante, F.M. Alparone, and M.V. Giuliani. Factors on Children's Independent Mobility and Relationship to Peer Frequentation. *Journal of Community Applications in Social Psychology*, Vol. 11, No. 6, 2001, pp. 435-450.
11. McDonald, N.C. Critical Factors for Active Transportation to School Among Low-Income and Minority Students: Evidence from the 2001 National Household Travel Survey. *American Journal of Preventive Medicine*, Vol. 34, No. 4, 2008, pp. 341-344.
12. Kerr, J., L. Frank, J.F. Sallis, and J. Chapman. Urban Form Correlates of Pedestrian Travel in Youth: Differences by Gender, Race-Ethnicity and Household Attributes. *Transportation Research Part D*, Vol. 12, No. 3, 2007, pp. 177-182.
13. McDonald, N.C. Children's Mode Choice for the School Trip: The Role of Distance and School Location in Walking to School. *Transportation*, Vol. 35, No. 1, 2008, pp. 23-35.

14. Timperio, A., K. Ball, J. Salmon, R. Roberts, B. Giles-Corti, D. Simmons, L.A. Baur, and D. Crawford. Personal, Family, Social, and Environmental Correlates of Active Commuting to School. *American Journal of Preventive Medicine*, Vol. 30, No. 1, 2006, pp. 45-51.

15. Zhu, X., and C. Lee. Correlates of Walking to School and Implications for Public Policies: Survey Results from Parents of Elementary School Children in Austin, Texas. *Journal of Public Health Policy*, Vol. 30, 2009, pp. S177–S202.

16. Wen, L.M., D. Fry, C. Rissel, H. Dirkis, A. Balafas, and D. Merom. Factors Associated with Children Being Driven to School: Implications for Walk to School Programs. *Health Education Research*, Vol. 23, No. 2, 2008, pp. 325-334.

17. Johansson, M. Environment and Parental Factors as Determinants of Mode for Children's Leisure Travel. *Journal of Environmental Psychology*, Vol. 26, No. 2, 2006, pp. 156-169.

18. van Acker, V., B.V. Wee, and F. Witlox. When Transport Geography Meets Social Psychology: Toward a Conceptual Model of Travel Behaviour. *Transport Reviews*, Vol. 30, No. 2, 2010, pp. 219-240.

19. Ajzen, I., and M. Fishbein. The Influence of Attitudes on Behavior. In D. Albarracín, B.T. Johnson, and M.P. Zanna (eds.), *The Handbook of Attitudes,* Lawrence Erlbaum Associates, Inc., Mahwah, NJ, 2005, pp. 173-221.

20. Bhat, C.R., C. Varin, and N. Ferdous. A Comparison of the Maximum Simulated Likelihood and Composite Marginal Likelihood Estimation Approaches in the Context of the Multivariate Ordered Response Model. In W. Greene and R.C. Hill (eds), *Advances in Econometrics: Maximum Simulated Likelihood Methods and Applications*, Emerald Group Publishing Limited, Bingley, UK, Vol. 26, 2010, pp. 65-106.

21. McKelvey, R.D., and W. Zavoina. A Statistical Model for the Analysis of Ordinal-level Dependent Variables. *Journal of Mathematical Sociology*, Vol. 4, 1975, pp. 103-120.

22. Greene, W.H, and D.A. Hensher. *Modeling Ordered Choices: A Primer*. Cambridge University Press, Cambridge, 2010.

23. Apanasovich, T.V., D. Ruppert, J.R. Lupton, N. Popovic, N.D. Turner, R.S. Chapkin, and R.J. Carroll. Aberrant Crypt Foci and Semiparametric Modelling of Correlated Binary Data. *Biometrics*, Vol. 64, No. 2, 2008, pp. 490-500.

24. Safe Routes to School. U.S. Travel Data Show Decline in Walking and Bicycling to School Has Stabilized. Press release, April 8, 2010.

25. Chen, Y., S. Ravulaparthy, K. Deutsch, P. Dalal, S.Y. Yoon, T. Lei, K.G. Goulias, R.M. Pendyala, C.R. Bhat, and H-H. Hu. Development of Indicators of Opportunity-based Accessibility. In *Transportation Research Record: Journal of the Transportation Research Board*, No. 2255, Transportation Research Board of the National Academies, Washington, D.C., 2011, pp. 58-68.

26. DiGuiseppi, C., I. Roberts, L. Li, and D. Allen. Determinants of Car Travel on Daily Journeys to School: Cross Sectional Survey of Primary School Children. *British Medical Journal*, Vol. 316, No. 7142, 1998, pp. 1426-1428.

27. Merom, D., C. Tudor-Locke, A. Baumana, and C. Risselb. Active Commuting to School among NSW Primary School Children: Implications for Public Health. *Health & Place*, Vol. 12, No. 4, 2006, pp. 678-687.

28. McDonald, N.C. Is There a Gender Gap in School Travel? An Examination of US Children and Adolescents. *Journal of Transport Geography*, Vol. 20, No. 1, 2012, pp. 80-86.

29. Sirard, J.R., and M.E. Slater. Walking and Bicycling to School: A Review. *American Journal of Lifestyle Medicine*, Vol. 2, No. 5, 2008, pp. 372-396.

30. Cooper, A.R., A.S. Page, L.J. Foster, and D. Qahwaji. Commuting to School: Are Children Who Walk More Physically Active? *American Journal of Preventive Medicine*, Vol. 25, No. 4, 2003, pp. 273-276.

31. Cooper, A.R., L.B. Andersen, N. Wedderkopp, A.S. Page, and K. Froberg. Physical Activity Levels of Children Who Walk, Cycle, or Are Driven to School. *American Journal of Preventive Medicine*, Vol. 29, No. 3, 2005, pp. 179-184.

32. Yarlagadda, A.K., and S. Srinivasan. Modeling Children's School Travel Mode and Parental Escort Decisions. *Transportation*, Vol. 35, No. 2, 2008, pp. 201-218.

33. Harries, K. Property Crimes and Violence in United States: An Analysis of the Influence of Population Density. *International Journal of Criminal Justice Sciences*, Vol. 1, No. 2, 2006, pp. 24-34.

34. Foster, S., and B. Giles-Corti. The Built Environment, Neighborhood Crime and Constrained Physical Activity: An Exploration of Inconsistent Findings. *Preventive Medicine*, Vol. 47, No. 3, 2008, pp. 241-251.

35. Pace, L., A. Salvan, and N. Sartori. Adjusting Composite Likelihood Ratio Statistics. *Statistica Sinica*, Vol. 21, No. 1, 2011, pp. 129-148.

36. Bhat, C.R. The Maximum Approximate Composite Marginal Likelihood (MACML) Estimation of Multinomial Probit-Based Unordered Response Choice Models. *Transportation Research Part B*, Vol. 45, No. 7, 2011, pp. 923-939.

37. Staunton, C.E., D. Hubsmith, and W. Kallins. Promoting Safe Walking and Biking to School: The Marin County Success Story. *American Journal of Public Health*, Vol. 93, No. 9, 2003, pp. 1431-1434.

38. Kearns, R.A., D.C.A. Collins, and P.M. Neuwelt. The Walking School Bus: Extending Children's Geographies. *Area*, Vol. 35, No. 3, 2003, pp. 285-292.

LIST OF TABLES

TABLE 1 Characteristics of the Sample Data

Parental Attitudes	
Sample Size	1000
Crime as an Issue	
Not an Issue	437
Little Bit of an Issue	178
Somewhat of an Issue	154
Very Much an Issue	87
A Serious Issue	144
Weather as an Issue	
Not an Issue	592
Little Bit of an Issue	183
Somewhat of an Issue	141
Very Much an Issue	43
A Serious Issue	41
Speed of Traffic as an Issue	
Not an Issue	180
Little Bit of an Issue	115
Somewhat of an Issue	223
Very Much an Issue	179
A Serious Issue	303
Volume of Traffic an Issue	
Not an Issue	175
Little Bit of an Issue	125
Somewhat of an Issue	199
Very Much an Issue	188
A Serious Issue	313
Distance to School an Issue	
Not an Issue	285
Little Bit of an Issue	126
Somewhat of an Issue	135
Very Much an Issue	156
A Serious Issue	298

Household Characteristics	
Sample Size	1000
Household Size	%
2	2.3
3	19.9
4	43
5 and above	34.8
Vehicles	%
No vehicles	2.1
1	14
2	47.7
3 and more	36.2
Income	%
Low	22.8
Medium	29
High	48.2
Race	%
Caucasian	59.9
Hispanic	19.7
Asian	9.6
African American	4.6
Other	6.2
Location	%
Urban Area	95
Non- Urban Area	5

School Characteristics	
Sample Size	1000
Mode to School	%
Car	68.7
Bus	9.4
Walk/Bike	20.7
Other	1.2
Mode from School	%
Car	63.2
Bus	11
Walk/Bike	24.9
Other	0.9
Distance to School	%
Less than 1 mile	38.4
Between 1 -2 miles	22.9
Over 2 miles	38.7
Type	%
Public School	85
Private School	15

Parent Characteristics	
Sample Size	1000
Father	
Worker	87.3
Education: Some College or Above	73
Mother	
Worker	58.7
Education: Some College or Above	69.7
Both Parents	
Both Parents are Workers	54.5
Both Parents are Full-time Workers	30

TABLE 2 Model Estimation Results

Variable		Crime	Weather	Speed of Traffic	Volume of Traffic	Distance to School
	Threshold 1	-0.358	-0.149[b]	-1.100	-0.670	-1.652
	Threshold 2	0.114[a]	0.408	-0.714	-0.242	-1.235
	Threshold 3	0.575	1.064	-0.110[a]	0.307	-0.818
	Threshold 4	0.913	1.438	0.379	0.822	-0.311[a]
School	Distance to school < ¼ mile	--	-0.419	--	--	-1.670
	Distance to school ¼ - 1 mile	--	--	--	--	-1.287
	Distance to school 1-2 miles	--	--	--	--	-0.867
	Distance to school over 2 miles	-0.218	--	0.303	0.390	
	Private school	0.176[b]	-0.254	0.173[b]	0.230	
Child	Age	--	--	-0.023	--	-0.037
	Male	-0.114[b]	--	-0.090[b]	--	-0.165
	No. of bike/walk trips per week	-0.012[b]	--	--	--	-0.015
Household	Race: Hispanic, Asian	--	0.365	--	--	--
	Race: Caucasian	--	--	--	0.135	--
	Race: Multiple	--	--	0.703	--	--
	Race: Pacific Islander, American Indian, Alaskan Native	--	--	--	--	0.320
	Race: White, Black, Pacific Islander	-0.280	--	--	--	--
	High income ($80K or over)	-0.188	-0.368	--	--	--
	Number of workers in household	0.056[a]	--	--	--	--
	Household Size	--	--	--	--	0.064
	Renter	--	--	--	--	0.145[b]
Parent	Father uses public transit	-0.287	--	--	-0.178	-0.175[a]
	Mother uses public transit	0.136[a]	--	--	--	--
	At least one parent uses public transit	--	0.165[b]	--	--	--
	Father: No. of hours walked/biked	--	--	0.023	--	--
	Mother: No. of hours walked/biked	--	--	0.016[b]	--	--
	Mother: No. of walk and bike trips	--	--	--	--	-0.009[a]
	Mother's education: some college or above	0.133[b]	--	--	0.264	--
	Mother's education: graduate school	--	--	0.272	--	0.225
	Father's education: less than high school	--	-0.248[a]	--	--	-0.380
	Mother has telecommuting option at work	--	-0.325[a]	--	--	--
	At least one parent has flexible work hours	-0.094[a]	-0.131[a]	--	--	--
	Mother has flexible timing at work	--	--	--	--	-0.185
	Both parents full time workers	--	--	-0.107[a]	-0.199	--
	Father has telecommuted from home	--	--	--	-0.214[b]	--
	Father's mode to work: transit, walk, bicycle	--	--	--	-0.373	--
	Mother's mode to work: transit, walk, bicycle	--	--	--	-0.287[b]	--
	Father's arrival time at work - AM	--	--	--	--	0.136
Built Env	Length of arterials (km) accessible in 10 min	0.001	--	--	--	--
	Length of freeways (km) accessible in 10 min	--	-0.004	-0.002	--	--
	Household is in non-urban location	--	--	--	-0.154[a]	--
Error Correlation	Crime	1.000	0.374	0.376	0.353	0.297
	Weather	--	1.000	0.223	0.214	0.259
	Speed of Traffic	--	--	1.000	0.838	0.450
	Volume of Traffic	--	--	--	1.000	0.544
	Distance to School	--	--	--	--	1.000

[a]not statistically significant
[b]statistically significant at 0.1 level