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Vivien Procher
Colin Vance

Heterogeneity in the Correlates of Motorized and Non-Motorized Travel in Germany

The Intervening Role of Gender

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Vivien Procher and Colin Vance[1]

Heterogeneity in the Correlates of Motorized and Non-Motorized Travel in Germany – The Intervening Role of Gender

Abstract

Drawing on individual-level mobility data from Germany between 1996 and 2009, this analysis econometrically investigates the determinants of automobile, public transit, and non-motorized travel against the backdrop of two questions: 1) Does gender play a role in determining the relative use of motor and non-motorized modes? 2) If so, how is this role mitigated or exacerbated by other socioeconomic attributes of the individual and the household? The results indicate that women display a relatively higher use of public transit and non-motorized modes coupled with a lower use of the car. However, it is important to qualify conclusions drawn with respect to the effect of gender given the range of confounding factors that mediate its impact, including age, the presence of children, the proximity to public transit, and the commute distance. The econometric estimates indicate that fare pricing and infrastructure provision have a significant influence on how individuals reach mode allocation decisions, and that women, in particular, stand to benefit from the maintenance of an efficient and dense public transportation network.

JEL Classification: D13, R20, R41

Keywords: Automobile travel; public transit; gender

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1. INTRODUCTION

In recent years, transportation policy in Europe has increasingly aimed at discouraging car use while simultaneously promoting public transit and non-motorized modes of travel. At the local level, these policies include congestion charges, caps on speed limits, reductions in parking spaces, bike sharing, and the establishment of car-free pedestrian zones (*1*). At the national level, high fuel taxes serve to additionally repress automobile dependency. In Germany, Europe's largest automobile market, taxes comprise roughly 70% of the fuel price, making prices at the pump over double the rate in the US (*2*).

Despite these measures, the transport sector continues to stymie Europe's efforts to reduce emissions of CO2. In 2006, transport was responsible for 21% of the European Union's total greenhouse gas emissions (*3*). While emissions have decreased in sectors such as industry and agriculture, road traffic is one of the few sectors in the EU-15 in which emissions have increased, rising by over a quarter between 1990 and 2005 (*3*). Nevertheless, the European Commission is intent on bucking this trend. Its most recent White Paper has set the ambitious goal of reducing transport emissions to 20% below their 2008 level by 2030 (*4*). Germany even exceeds these goals by aiming for an emission reduction of at least 20% a decade earlier by 2020.

With roughly 60% of transport emissions attributable to private automobiles (*5*), achieving this target will critically depend on improved understanding of how households trade-off between automobile use and other transport modes. The impact of gender, in particular, is relevant to such assessments inasmuch as substantial differences between women's and men's mobility behavior have been observed with respect to car- and public transit use (*6-7*). With few exceptions (e.g. *8*), women are found to be the predominant transit customers, one explanation for which is that their use of the car is often limited by so-called patriarchal constraints that dictate priority car-access for men (*9*). Nevertheless, the combined effects of entry into the labor force coupled with continued household- and childcare responsibilities have impelled many women to adapt increasingly complex travel patterns (*10-12*). One outcome of these multiple responsibilities is a greater reliance on the car, which in Germany is evidenced by an increase in the share of vehicle kilometers driven by women from 31% in 1996 to 38% in 2008.

While the shifting pattern in the role of women in the household has undoubtedly impacted their propensity to use the car, there is to date a dearth of conclusive evidence on how the relationship between socioeconomic circumstance and mode use differs by gender. Although several studies have suggested that women have unequal access to the car and conduct more of their travel by public transportation or by foot (*13-16*), dissenting evidence has also emerged that points to little difference between men and women in private automobile use (*17-18*). Turning to some of the studies conducted on the relation between gender and travel in the German context, Heine, Mautz and Rosenbaum (*19*) find that children are the most important factor in increasing female car use, which they attribute to the traditional role of women in assuming shopping and accompaniment duties, as well as to security aspects of caring for children in the case of emergencies. Matthies, Kuhn, and Klöckner (7) explore differences in environmental attitudes and habits by gender, finding that women have stronger intentions to reduce car use owing in large part to their stronger concerns about the environment.

A more recent analysis of German households by Vance and Iovanna (*20*) focuses on the role of sociodemographic attributes. Similar to Heine, Mautz and Rosenbaum (*19*), it finds that while women use the car less than men, this difference diminishes with the presence of

children and with the availability of a car. A study by Best and Lanzendorf (*21*) of households from the German city of Cologne, however, reveals a different pattern. The authors hypothesize that the additional time constraints and related demands of parenthood would increase car use, especially for women, but find the opposite to hold: parenthood reduces the odds of car use by women while increasing it for men.

On the whole, the literature reveals a rather mixed – and somewhat contradictory – picture of the nature and sources of disparities in mobility patterns between women and men, particularly as regards the question of car use. Moreover, the existing body of evidence provides little insight into how the influence of policy-relevant variables, such as land use features, vary by gender. The present paper aims to fill these voids by estimating an econometric model of modal shares on travel-diary data collected in a nationwide survey of German households. Germany provides a particularly interesting case study because of several trends pointing to an increased share of women in the pool of automobile drivers, including higher labor force participation rates among women and a growing proportion of women in possession of a driver's license.

In recognition of these trends, public transit authorities throughout Europe and Germany have incorporated the principle of "gender mainstreaming" into transport policy. First adopted as a general basis for social policy by the European Union in the Treaty of Amsterdam (1997), gender mainstreaming in the transport arena comprises two main principles: (1) establishing gender-equality in mobility opportunities by recognizing gender differences in home life, the labor market, and overall lifestyle patterns, and (2) the introduction of gender considerations in the evaluation of transport projects. As local planning agencies across Germany put these principles into practice, (e.g. *22-23*), improved understanding of how women and men differ in their travel patterns assumes increased importance.

This paper builds on the transport and gender literature in several respects. First, by modeling modal shares, our analysis illuminates how individuals substitute between car and public transit usage, the two most dominant modes. Second, beyond testing the effect of gender, we include interaction terms to explore whether this effect is modified by other socioeconomic attributes describing the individual and the household in which they reside. We are specifically interested in testing for differential effects of gender by age, employment location, the presence of children, the holding of a driver's license, the availability of an automobile, and the proximity of public transport, six factors that are frequently cited as accounting for variations in the share of female drivers. Finally, our assessment of these factors moves beyond the standard focus on the significance and magnitude of the parameter estimates to consider their implications for predicted outcomes. To this end, we implement a Monte Carlo simulation technique proposed by King, Tomz and Wittenberg (*24*) to explore the predictions of the model and, more importantly, the associated degrees of uncertainty.

The remainder of the paper is organized as follows. The next section describes the data, including the measurement of the dependent variable and relevant descriptive statistics to aid the interpretation of the model results. Section three describes the model specification. Section four catalogues the results, and section five concludes.

2. DATA

The main data source used in this research is drawn from the German Mobility Panel (MOP), a multiyear travel survey financed by the German Federal Ministry of Transport, Building and Housing (*25*). Participating households are surveyed for a period of one week over three

consecutive years. Households exiting the panel after the three years of the survey are replaced by new cohorts of households who are in turn surveyed for three years, with the cycle continually repeating itself. The data used in this paper spans 14 years of the panel, from1996 to 2009, and is limited to the travel of individuals over 17 years of age during the 5-day work week. Of these, 3817 participate in all three years of the survey, 2645 participate in two years, and 3432 participate in one year, yielding a total of 20173 observations on which the model is estimated. To correct for the non-independence of repeat observations over multiple time points in the data, the regression disturbance terms are clustered at the level of the individual, and the presented measures of statistical significance are robust to this survey design feature.

Individuals that participate in the survey are requested to fill out a questionnaire eliciting general household information and person-related characteristics, including zip code of residence, gender, age, employment status and relevant aspects of everyday travel behavior including transportation mode and travel distances. In addition to this general survey, the MOP includes a separate survey focusing specifically on vehicle travel. This so-called "tank survey" draws a random 50% sub-sample of car-owning households from the overall MOP survey (which also includes households that do not own a car – about a 20% share in Germany). The tank survey takes place over a roughly six-week period, during which time respondents record various automobile related information, including the price paid for fuel.

As this variable is a potentially important determinant of modal shares, it was linked with the larger sample of households in the MOP analyzed here by using a Geographic Information System to create a coverage of spatially interpolated fuel prices (in real terms) for all of Germany. The coverage was then overlaid onto the map of household locations in the MOP data, thereby allowing for each household to be assigned the locally prevailing fuel price. This process was repeated for each year of the data, yielding a dataset of fuel prices that varies over space and time. An accuracy assessment of the data was undertaken by calculating the yearly average fuel prices and comparing these with those published for the German market by the oil company Aral (*26*). The correspondence between the two sources is tight, deviating by an average of less than 1% over the 1996-2007 time-interval (*27*).

In addition to fuel prices, another important cost-determinant of public transit use is the fare. Data on this variable was obtained by an internet-based survey that retrieved the price in 2009 for a monthly pass for each of the 90 regional transit authorities (Verkehrsverbünde) in Germany. Each household was then assigned the monthly fare of the Verkehrsverbund in which it is situated. Fares were converted into real terms using a consumer price index that adjusted for the relative price inflation of public transport in Germany so that this variable also varies over time and space. We also explored the use of the trip fare in place of the monthly fare but found that this had little bearing on the results.

The dependent variable modeled in this analysis, the share of travel by mode over the 5-day week, is derived from a measure of the total distance traveled and its breakdown by car, public transit, and non-motorized modes (i.e. walking and cycling). Table 1 presents descriptive statistics that provide some insight into the pattern of modal shares by gender. Overall, men are more mobile, traveling an average of 247.78 km per week compared with 165.17 km for women. This difference probably reflects to some extent the higher employment rate of men – 56% versus 46% for women – as well as a longer average commute distance for men, alluded to further below.

With respect to the individual modes, the largest difference – in percent and absolute terms – between men and women exists for car travel. During the week, men travel an average of 202 kilometers by car, 61% more than the 126 kilometers traveled by women. Men also travel more by public transit and non-motorized modes, but in these cases the percent differences are considerably smaller – 17.5% and 6.4%, respectively. In relative terms, women use public transit and non-motorized modes more than men but use the car less. While women undertake 17.7% and 6.3% of their total travel by public transit and non-motorized modes, the corresponding figures for men are 13.8% and 4.4%. The car is the dominant transport mode for both sexes, used for 81.7% of total weekly travel by men and 76.1% by women.

TABLE 1: Travel by gender and mode

	Mean	SD	% of total travel	Difference in means	t-test
Total travel (km)					
Male	247.78	262.27	100%		
Female	165.17	176.22	100%	82.61	26.487
Travel by car					
Male	202.48	245.43	81.7%		
Female	125.63	159.42	76.1%	76.85	26.623
Travel by public transit					
Male	34.30	128.75	13.8%		
Female	29.20	95.13	17.7%	5.10	3.220
Non-motor travel					
Male	11.00	19.82	4.4%		
Female	10.34	21.64	6.3%	0.66	2.253

Number of observations: 10611 men and 9572 women

3. MODELING APPROACH

Given the interrelated nature of modal allocation decisions, the empirical methodology proceeds by specifying a set of travel share regression equations to assess the determinants of travel shares undertaken by car, public transit, and non-motorized modes. In restricting the analysis to weekday travel, we assume that individuals follow regular activity patterns due to recurring employment, childcare or household duties during the week, allowing us to think of a fixed travel budget (i.e. total kilometers traveled) per person. Hence, the setup resembles a utility maximization problem where the relative usage of various transportation modes is optimized subject to an exogenously given travel budget.

Estimation of the shares is undertaken using ordinary least squares (OLS), with the entire set of explanatory variables entered into all three regressions. Three separate regressions are independently estimated. The first models the share of total travel undertaken with the car, the second the share undertaken with public transit, and the third the non-motorized share, thereby accounting for all modes. Given the zero-sum nature of modal allocation decisions, if an explanatory variable has a significant and positive effect on the use of one type of transport, then it must have a negative effect on some other type(s). Conversely, a negative coefficient in one of the share models must be offset by a positive coefficient in another. In fact, as noted by Berndt (*28*), because the observed shares themselves sum to unity at each observation, the equation-by-equation application of OLS yields estimates that sum to one for each parameter (i.e. $\beta_{nonmotor} + \beta_{car} + \beta_{transit} = 1$).

The suite of variables selected for inclusion in the model measures the individual-, household- and transportation attributes that are hypothesized to influence the allocation of travel expenditures in maximizing utility. Variable definitions and descriptive statistics are presented in Table 2, broken down by gender. For the majority of household and transportation variables, the differences between the genders are minimal, but some notable distinctions are seen for the individual attributes. Confirming a pattern observed in most industrialized countries, we see for example that among employed persons, men have a substantially longer commute than women – 19 versus 12 kilometers. Moreover, 92.2% of the male respondents have a driver's license compared to 81.3% of the female respondents. Finally, women in the sample have lower completion rates of a college preparatory degree (Abitur), whereby the shares of 40% for men and 31% for women are in line with figures reported by Germany's Statistisches Bundesamt for people in the age group between 40 and 44 (*29*).

TABLE 2: Variable definitions and descriptive statistics by gender

		MALE		**FEMALE**	
	Definition	*Mean*	*SD*	*Mean*	*SD*
Individual characteristics					
Female	1 if respondent is female, 0 otherwise	**0.474**		**0.526**	
Age	age of respondent	**50.19**	16.09	**49.66**	15.90
Age^2	age squared of respondent	**2778.10**	1618.20	**2718.45**	1594.97
Abitur	1 if respondent has Abitur, 0 otherwise	**0.401**		**0.314**	
License	1 if respondent has a driving license, 0 otherwise	**0.922**		**0.813**	
Distance to work	if employed, weekly distance to work (in km)	**18.86**	27.10	**11.97**	15.16
Household characteristics					
Income	household income	**2445.2**	818.8	**2293.3**	856.6
City	1 if residence is located in an urban area, 0 otherwise	**0.299**		**0.322**	
Number kids	number of children under 18 in the household	**0.471**	0.850	**0.482**	0.851
Car availability	1 if number of cars in household is ≥ number of drivers, 0 otherwise	**0.514**		**0.492**	
Transportation characteristics					
Minutes	walking minutes from residence to the nearest public transit stop	**5.602**	4.757	**5.780**	4.812
Railtransit	1 if nearest transit stop is serviced by rail, tram or U-Bahn, 0 otherwise	**0.118**		**0.119**	
Transit service	Service density of transit system	**33.47**	45.97	**36.11**	51.85
Fare price	monthly fare price for transit pass	**36.20**	8.57	**36.23**	8.425
Petrol price	real petrol price	**1.018**	0.119	**1.021**	0.118
Others					
Total distance	total weekly distance travelled by respondent	**247.78**	262.27	**165.17**	176.22
Year	year of survey	**2002.55**	3.95	**2002.63**	3.91
_n		*9572*		*10611*	

To allow for differential effects by gender, the econometric specification interacts six of the explanatory variables – *age, license, car availability, number kids, distance to work* and *minutes to the nearest transit stop* – with a female dummy variable. These variables are of particular interest as they are indicative not only of life cycle stages over which mobility behavior is expected to fluctuate, but also of major socio-demographic changes currently underway in Germany that could dramatically affect future automobile dependency. Between 2000 and 2005, for example, the birth rate decreased some 9.3%, from 9.18 to 8.33 births (per

1000 inhabitants), having already decreased 19.5% over the preceding decade (*30*). This trend has been paralleled by an increasingly older age structure of the German population as well as by an increase in the participation rate of women in the pool of drivers and in the labor force, with the latter rising from 55.1% in 1994 to 65% in 2009 (*31*). While several studies have suggested that these changes will have profound consequences for transport demand in Germany (*32-34*), the anticipated impacts are largely speculative, and there have been few attempts to quantify how the underlying variables affect travel behavior at the individual level.

While the econometric specification contains reasonably broad coverage of the range of variables determining modal shares, the possibility of omitted variable bias can never be completely ruled out. It may be the case, for example, that unobserved attributes like environmental attitudes attract households to settle in dense urban neighborhoods where environmentally friendly modes of transit can be substituted for car use. To the extent that such a self selection process is at play, it may bias some of the coefficient estimates, particularly those measuring urban form. We consequently abstain from making claims about causality, and instead apply a descriptive interpretation to the estimates. As an area for future research, we note that qualitative work based on opened-ended questions can serve to complement econometric studies such as this by probing deeper into the underlying motivations behind mobility patterns.

4. RESULTS

Alternative variants of the model were explored that pooled the data and incorporated individual-level fixed effects to exploit the panel dimension of the dataset. Although the fixed effects approach has the virtue of controlling for unobservable influences that stay fixed over time, its drawback is its reliance on within person temporal variation to identify the effects of the variables. If this variation is limited, the precision of the estimates is compromised. Such was found to be the case with the present data. Most of the explanatory variables vary little, if at all, over the three years of the survey, with the consequence that the fixed effects estimates have very high standard errors. We therefore focus attention on the pooled estimates.

Table 3 catalogues the results from the three share equations. Among the coefficients that are statistically significant, most have signs that are consistent with intuition. Turning first to the respondent attributes, *age*, which is specified as a quadratic, displays an inverse u-shaped relationship in the car regression so that increases in age initially increase but subsequently decrease the car share in total travel, with the peak in the car share occurring at around 51 and 50 for men and women, respectively. In contrast, a u-shaped relationship in the public transit equation suggests that over the lifespan both sexes initially decrease their share in transit before it increases again, with the lowest transit share occurring at around age 59 for men and 54 for women. *Education* is seen to have a negative effect on the share traveled by car contrasted by positive effects on the shares traveled by public transit and non-motorized modes, a possible reflection of more pronounced environmental consciousness among people with an Abitur.

Not surprisingly, possession of a *driver's license* has an opposite effect, increasing the share traveled by car and decreasing the shares by the other modes. As indicated by the interaction term, the positive effect on the car share is significantly weaker for females. Specifically, while male holders of a driver's license have a 35.5 percentage point higher car share than non-holders, the car share for female holders increases only by 28.8 percentage points.

TABLE 3: Regression results

	Car	Transit	Non-motor
Individual characteristics			
Female	0.0175	-0.0464	0.0289
	(0.552)	(0.113)	(0.236)
Age	0.0082	-0.0098	0.0015
	(0.000)	(0.000)	(0.073)
Age (squared)	-0.0001	0.0001	0.0000
	(0.000)	(0.000)	(0.764)
Age*female	-0.0002	0.0008	-0.0006
	(0.559)	(0.020)	(0.034)
Abitur	-0.0786	0.0480	0.0306
	(0.000)	(0.000)	(0.000)
License	0.3547	-0.2302	-0.1245
	(0.000)	(0.000)	(0.000)
License*female	-0.0670	0.0635	0.0035
	(0.001)	(0.001)	(0.848)
Distance to work	-0.0005	0.0004	0.0001
	(0.009)	(0.024)	(0.358)
Distance to work*female	0.0001	0.0012	-0.0013
	(0.697)	(0.004)	(0.000)
Household characteristics			
Income	0.0001	-0.00003	-0.00002
	(0.000)	(0.000)	(0.000)
City	-0.0287	0.0264	0.0023
	(0.014)	(0.010)	(0.804)
Number kids	0.0048	-0.0072	0.0024
	(0.327)	(0.091)	(0.449)
Number kids*female	0.0061	-0.0120	0.0059
	(0.362)	(0.030)	(0.205)
Car availability	0.1711	-0.1000	-0.0710
	(0.000)	(0.000)	(0.000)
Car availability*female	0.0569	-0.0407	-0.0161
	(0.000)	(0.000)	(0.037)
Transportation characteristics			
Minutes	0.0023	-0.0006	-0.0017
	(0.001)	(0.280)	(0.001)
Minutes*female	0.0006	-0.0019	0.0013
	(0.564)	(0.021)	(0.087)
Railtransit	-0.0611	0.0578	0.0033
	(0.000)	(0.000)	(0.588)
Transit service	-0.0011	0.0012	-0.00004
	(0.000)	(0.000)	(0.682)
Fare price	0.0012	0.0003	-0.0015
	(0.010)	(0.537)	(0.000)
Petrol price	-0.0272	0.0163	0.0109
	(0.443)	(0.585)	(0.672)
Others			
Total distance	0.0001	0.0001	-0.0003
	(0.000)	(0.000)	(0.000)
Year	-0.0068	0.0030	0.0038
	(0.000)	(0.007)	(0.000)
Constant	13.7322	-5.4764	-7.2558
	(0.000)	(0.014)	(0.000)
n	*20183*	*20183*	*20183*

p-values in parentheses

Lastly, the *commute distance* also emerges as an important determinant in modal shares, and one for which significant differences by gender are evident for the transit and non-motorized shares. Interestingly, longer commutes are associated with a decreased share traveled by car and an increased share traveled by transit, with the latter effect being significantly stronger for females.

With respect to the household-level attributes, the models confirm the importance of income, urban residency, children, and car availability as determinants of modal shares. Given that the fixed and operating cost of a subcompact car amounts to 382 Euros per month (*35*), representing a large share of the average household budget, it is not surprising that an increase in household *income* has a positive effect on car usage and a negative effect on transit. Specifically, an increase in real income by 100 Euros increases the car share by 0.6 percentage points. Moreover, the *city* dummy indicates that urban residents are heavier users of public tranit (+2.6 percentage points) but lighter users of the car (-2.9 percentage points). As indicated by a joint significance test, the coefficient on *children* is also positive in the car share model and negative in the model for transit. Specifically, each additional child reduces the transit share by 0.7 and 1.9 percentage points for men and women, respectively. *Car availability* is another determinant whose effect varies significantly by gender. The positive coefficient on this variable in the car regression and its negative coefficient in the transit regression are in both cases more pronounced for females.

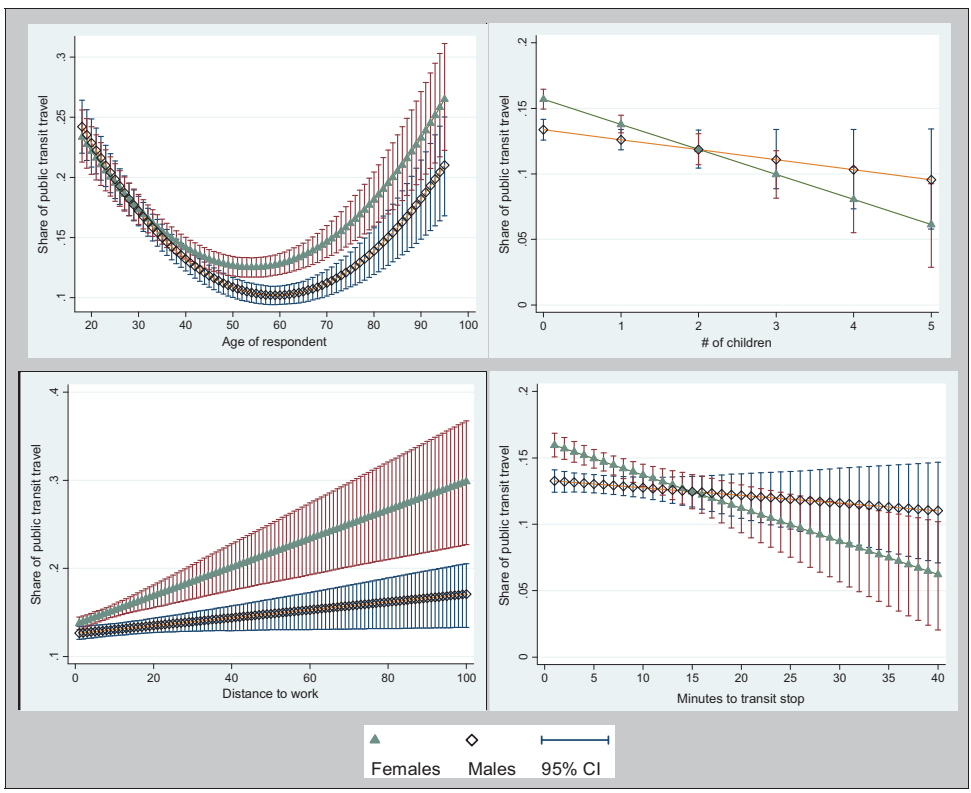
Finally, the model reveals several transportation and land use attributes that impact modal shares, some of which can be directly influenced by policy-makers. The walking time to the nearest transit stop (*minutes*), for example, has a negative impact on the share traveled by transit that is significantly stronger for women. Also, the dummy indicating whether that nearest stop is serviced by rail, tram or underground train (*railstransit*), which tend to be faster and afford greater comfort than bus, is positively associated with the transit share and negatively associated with the car share. Likewise, increases in the transit *service density* variable, which captures reduced wait times and a higher frequency of stops, has a positive coefficient in the transit equation and a negative coefficient in the car equation. While the *petrol price* is statistically insignificant – a possible consequence of its correlation with the year trend – increases in the *fare level* are seen to positively affect the share traveled by car and negatively affect the non-motor share, with the latter result likely reflecting the fact that transit use is generally coupled with non-motorized travel either by foot or by bike.

The remaining control variables show that the usage of cars increases with the *total travel distance*. Each additional kilometer increases (decreases) the car (transit) share by 0.01 percentage points. The larger and the more complex weekly travel patterns are, the more convenient is travelling by car as it offers the fastest door-to-door transportation. In addition, a *year* trend that controls for autonomous macro-level changes over time shows that there has been growing movement in Germany in recent years to use the public transport instead of the car.

Returning to the question of gender differences, further insights can be extrapolated from Figure 1, which shows the simulated transit shares and 95% confidence intervals for several explanatory variables following the Monte Carlo technique of King, Tomz and Wittenberg (*24*). In the upper left graph of Figure 1, the simulations are generated over a range of ages for men and women while holding the other variables in the model fixed at their mean values. Roughly up to the age of 35, both sexes have a very similar (and decreasing) predicted probability for public transit shares, whereas thereafter the decrease is stronger for men than for women before both shares increase again. Statistically significant gender differences are,

however, limited to the age span between 50 and 80 where there is no overlap of the confidence intervals. As regards the simulated probabilities with respect to the number of children in Figure 1 (upper right graph), childless women have a higher probability than men to use the public transport system, but a reversal usage pattern occurs for households with two or more children. Nevertheless, the predictions are only statistically significant at the 5% level for households with less than two children.

FIGURE 1: Simulated probabilities of public transit shares by age, number of children, distance to work and minutes to transit stop



With respect to the commute distance, Figure 1 (lower left graph) illustrates that women have a significantly higher transit share over the entire distance range. The fact that both sexes are more likely to use the public transport system the further away their work place, may reflect the high efficiency and convenience of the German railway system, making it a viable transportation option for daily commuters, including those in the suburbs away from employment centers. Finally, with reference to the simulated probability for the minutes to the next transit stop, as depicted in Figure 1 (lower right graph), women initially start with a significantly higher transit share than men, however, women also reduce their transit usage much faster with an increase in the walking distance. In sum, women are more responsive to the service and accessibility of the public transport system.

5. DISCUSSION AND CONCLUSION

Focusing on individual weekday travel in Germany, this paper has investigated the determinants of automobile, public transit, and non-motorized travel. Germany provides an illustrative case study of this issue for several reasons. On the one hand, the country has one of the highest rates of car ownership in Europe – 551 cars per 1000 inhabitants compared with 780 in the U.S. (*36*). On the other hand, Germany has enjoyed some success in tamping down CO2 emissions in the transport sector, which grew by just 1% between 1990 and 2005 compared with a 26% increase in the EU as a whole (*3*).

Our analysis focused specifically on two questions: 1) Does gender play a role in determining relative reliance on the car and public transit? 2) If so, how is this role mitigated or exacerbated by other socioeconomic attributes of the individual and the household? These questions were pursued through a combination of descriptive analyses and econometric methods, the latter of which focused on models of travel shares undertaken by car, public transit, and non-motorized modes.

The descriptive statistics presented at the outset confirmed a general pattern found in many industrialized countries. Women travel less than men, both in terms of total kilometers and when broken down by mode. A large part of this difference can likely be attributed to the fact that women have lower rates of employment and, among those who do work, have substantially shorter commute distances than males. In this regard, the econometric modeling indicated that it is important to qualify conclusions drawn with respect to the effect of gender given the range of confounding factors that mediate its impact. Specifically, it was found that the variables measuring age, license possession, the presence of children, the proximity to public transit, the commute distance and car availability all have significant gender-specific effects on the relative choice of travel modes.

Several policy implications can be derived from these results. Most generally, the estimates indicate that fare pricing and infrastructure provision have a significant influence on how individuals reach mode allocation decisions. The frequency of public transit service, its proximity, and its cost are all seen to either increase public transit use while often simultaneously decreasing car usage. With respect to the particular question of gender differences, the results additionally indicate that planners should be cognizant of the influence of traditional gender roles in constraining female mobility, especially as regards the question of car use. This is most clearly evidenced by the positive coefficient on the variable measuring car availability, the magnitude of which is stronger for women than men.

Viewed alternatively, the result implies that having fewer cars than drivers available in the household disproportionately reduces female car use, a finding which is consistent with Pickup's observation (*9*) that "the general pattern is for husbands to have first choice of car-use." The prevalence of such a pattern would also explain the result that women are more responsive to the proximity of the nearest transit stop. In the context of the current efforts in Germany to promote "gender-mainstreaming," these findings support the proposition that women stand to benefit more from policies that improve access to and coverage of the public transit system, which in turn allows for a more efficient combination of employment, household and childcare duties.

Looking to the future, the analysis points to promising prospects that the German population will continue to maintain a relatively high share of trips by so-called green modes (public transit, bicycle, and foot), which in 2004 comprised roughly 40% of all trips (*36*). Although the country is suburbanizing, particularly in the east (*37*), this need not augur an increase in

car dependency. As seen in the model results, the share of public transit use is positively related to distance to work, suggesting that transit is viewed as a viable commute option even among workers who live in the suburbs and especially among women, who will continue to comprise an increasing share of the workforce. The results also indicate that the rapid aging of German society will lead to an increased use of public transit coupled with a decreasing use of the car. Taken together, these findings suggest that continued investment in and expansion of Germany's public transit network is warranted.

With respect to future research, we see two related questions that would lend themselves to analysis with the MOP data. The first regards the implications of differing activity-patterns for mode dependency. The MOP contains very detailed information on the daily time allocations to work, maintenance, and recreational activities over the course of the week. An interesting line of inquiry would explore differences in these allocations by gender and subsequently link them to mode use decisions. In particular, one could explore the extent to which different activity patterns give rise to different travel patterns. A second line of inquiry would involve exploiting the georeferenced information in the data to probe more deeply the role of land use pattern on mode use and how this varies by gender. Variables on the zip code and county in which the household is located, for example, could be used to link the data with other sources such as satellite imagery, thereby enabling spatially explicit modeling of the impact of urban form on mobility.

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