Gendered patterns of work trip mode choice– evidence from Germany

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Abstract

In this paper, we examine the gender differences (or similarities) by exploring the association between work trip mode choice and five key elements: i) personal socio-economic status; ii) household attributes, iii) spatial-temporal fixity, iv) partner interaction and v) work hour preferences. We use the German National Time Use Survey 2012 and adopt multinomial logit analysis. Our results suggest that factors such as personal income, car ownership, low-dense settlement, free working schedules, time spent in unpaid activities had a significant positive effect on both men's and women's car use. In contrast, the household income, education, market and non-market economic sector, flexible working schedule, commute distance, partners' time spent in unpaid activities had a significant positive effect on men's and women's public transport usage.

Keywords: commuting, mode choice, gender roles, spatial-temporal fixity, partnership, preference

1 Introduction - Research question and hypotheses

The question of gender differences in travel mode availability and mode choice has been debated and researched in transport research. They are characterized by the inequalities in economic power and access to labour markets, the gender division in paid and unpaid work, access to individual and household resources, differential preferences and attitudes towards travel modes (Nobis and Lenz, 2005; Hanson 2010; Lanzendorf 2010). From a longitudinal perspective, considerable signs of convergence in mode choice were observed and attributed to increasing labour force participation of women, the associated declining trend in the normative male-breadwinner-female-housewife-model, and increasing levels of licensing and personal car ownership with women catching up to men over time (Beckmann et al., 2005; Konrad, 2016).

Despite the convergence, there are several reasons why the gender-travel nexus has remained on the agenda in research and policy. First, the travel differences between men and women connect to space-time constraints at the possible expense of gender equity and, thus, fairness and social sustainability. Second, the general lack of information restricts the ability to understand the causal mechanisms of gender differences in mode choice, e.g. income inequality measured at household level uses household income due to the non-availability individual income. Third, while there is abundant research on intra-household interactions in travel behaviour, such interactions have rarely been systematically included in gender/travel studies. For instance, the evidence of how partner's time-space constraints, social role preferences shape individual mode choices is still limited.

In this paper, we study the commute mode choice from a gender perspective through multinomial logit analysis. The novelty of the paper lies in the simultaneous consideration of diverse variables that

reflect social (gender) roles, preferences, individual and household resources, and interpersonal interaction to better understand work-trip mode use. In particular, the personal income of individual partners has rarely been considered in related research. The same is true for time-use preferences (rather than realised time-use), and for interactions in two partners' activity and travel behaviour. In this study, we address critical questions left unanswered in the literature by comparing male and female respondents who are either married or cohabiting: Do spatial, temporal and economic constraints shape individual work-trip mode choice? How do partners' temporal constraints influence individuals' decisions on work-trip mode? Do preferences for working hours determine commute mode choice decisions?

We explore the gender differences (or similarities) in work trip mode choice by investigating its association with the five key factors. First, we aim to explore the effect of socio-economic on work trip mode choice of men and women. We expect the increase in personal income and education level tends to increase both men's and women's driving over other modes. Second, we examine the household attributes of men and women. Here, we expect that having cars and having young children may more likely increase women's (also men's) driving. Third, we aim to assess the effect of space-time fixity attributes on the commute mode choice behaviour of men and women. In particular, we expect that the time spent in shopping may increase men's driving over other travel mode choices, whereas the working hours, time spent in child care and errands tend to positively impact women's driving over other travel modes. Fourth, we analyse the effect of partner time-space constraints on men and women's commute mode choice. Here, we expect the increase in partner's time spent in fixed temporal activities such as working hours, childcare may increase men' s/women's usage in public transport, whereas partners time spent in shopping and errands may positively impact men' s/women's commuting by car. Finally, we focus on interconnectivity between preferred working hours and commute mode choice behaviour. Based on this, we expect that male partners from traditional work hour preference may most likely drive, but those with egalitarian attitude may more likely use other modes, and for women, we expect the opposite.

2 Data and Methods

We use the German Time Use Survey (GTUS) 2012/13 data for our study (FDZ 2013). It comprises of specific socioeconomic, demographic, and three-day activity, travel and mode-use patterns. In travel time diary, respondents from 4775 households self-reported their daily activities (primary and secondary) in time plan sheets and their transport mode: 1. cars, (car, motorbike), 2. public transport (bus, train, tram), 3. walking, and 4. cycling for a continuous 24 hours (i.e. from 4:00 AM to 4:00 AM next day) over three random days (two weekdays and one weekend day), with ten-minute intervals.

The outcome variable for work-trip mode choice model indicates the individuals' mode choice among the four transport alternatives: cars, public transport, cycling and walking for work trips (to or from work) per day. As the research includes work trips made by the partnered respondents, our sample narrowed down to 9438 work trips (M:5455; W:3983). Compared to partners with older children (greater than 10 years) or childless couples, those with younger children have additional responsibilities to perform non-mandatory activities and trips like childcare and escort. Hence, we believe that partnered respondents with young children may have different patterns of work-trip mode choice than those without. To investigate this, we split the sample into two groups: partnered respondents with young children and those without young children.

We use the descriptive summary of variables to explain the intra and inter-gender differences across the two groups: partnered respondents without young children and those with young children. Table 1 shows the commuting trips of all respondents classified by presence of children in the household[1]. Among men, about 60 percent of work trips are from full-time working men without young children, while among women, about 50 percent of total work trips are part-time working women without young children.

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[1] Here the households without young children include childless respondents, and respondents with at least one child more than ten years of age, and households with young children include the respondents with at least one child below 10 years

Table 1. Partnered respondents working trips versus working status

	Partnered men N (%)	Partnered women N (%)
	w/o young child(ren)	*w/o young child(ren)*
Full-time	3287 (60.3)	1063 (26.7)
Part-time	233 (4.3)	1884 (47.3)
	with young child(ren)	*with young child(ren)*
Full-time	1790 (32.8)	264 (6.6)
Part-time	145(2.6)	772 (19.4)
Total	**5455 (100)**	**3983 (100)**

Independent sample t-tests were performed to examine gender differences between male and female respondents and a chi-square independence test was applied to investigate if there is an association between variables and gender composition. The results[2] indicate that on average, male respondents have higher mean scores in commute distance, personal income, working hours and work hour preferences. In contrast, female respondents have a higher mean score in unpaid work: shopping, childcare and errands. From Figure 1, we observe some changes in mode shares of men and women across groups. Compared to women without young children, those with young children accounted for a higher proportion of work trips by cars (73%) and a lower proportion of trips by public transport, cycling and walking. Conversely, men with young children has a slightly lower commuting share by cars (74%) and a higher share of public transport (11%) and walking (7%) compared to those without young children.
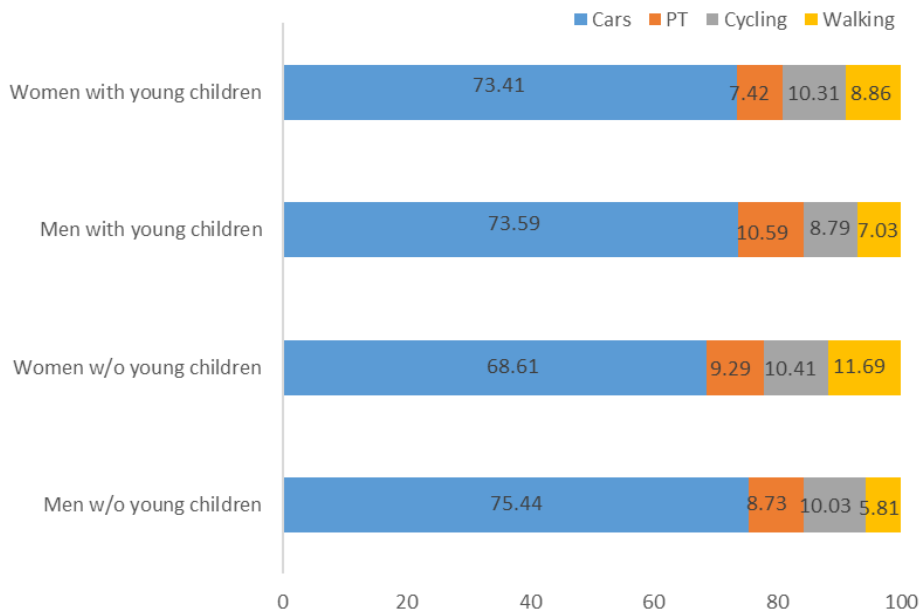

Figure 1: Work trip mode shares of partnered respondents (%)

Using multinomial logit regressions, we have estimated coefficients to examine the association between work trip mode choice and five groups of variables: (a) personal socio-economic status, (b) household attributes (c) spatial-temporal fixity constraints, (d) interpersonal interaction within partners, and (e) work-hour preferences. Table 2 provides detailed information. We generate four models: working male partners without young children (Model 1), working female partners without young children (Model 2), working male partners with young children (Model 3) and working female partners with young children (Model 4). Alongside the coefficient estimates, marginal effects are calculated for each variable. The average marginal effects of independent variables on mode choice probabilities are expressed as percentage changes in probabilities associated with a 1% change in each independent variable. The values presented are marginal effect taken at the average of the predicted counts in the model (average ME or AME).

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2 Due to word restriction, we could not report the descriptive summary.

Table 2. Variables used in the analysis

	Variables	Levels
Personal socio-economic status	Personal monthly income	(Poor)less than or equal to €800/month (Low)-€800 to €1600/month (Middle)-€1600-€2450/month (High) greater than or equal to €2450/month
	Years of education	metric
	Type of economic sectors	(Industry) mining, manufacturing, energy, water supply, sewage, construction (Market)wholesale/retail trade, passenger and goods, hospitality, information and communication, banks, real estate, freelance, other economic services (Non-market) public administration, education and teaching, health and social worker, arts, entertainment, consulate, embassy
Household attributes	Household monthly income	(Poor) less than or equal to €2750/month (Low) €2750 to €3800/month (Middle) €3800 to €4750/month (High) greater than or equal to €4750/month
	Number of cars per household	metric
	Number of children below 10 years	metric
Spatial fixity	Spatial environment (inhabitants/km2)	(Urban) cities with a population of at least 100,000 (Municipal)districts with a population share in large and medium-sized cities of at least 50% and the population density of at least 150 inhabitants/km² (High-density rural) districts with a population share of at least 50% in large and medium-sized cities and the population (Low-density rural) density lesser than 150 inhabitants/km². districts with a population share in large and medium-sized cities below 50% and a population density without large and medium towns below 100 inhabitants/km².
	Respondents commute distance (km)	(< 10km) short-distance commuting (10-25km) medium-distance commuting (>25km) long-distance commuting
	Apartment area (sqm)	metric
Temporal fixity	Respondent working hours (h/day)	metric
	Respondent working schedule	(Fixed-time) fixed start and end time (Flexi-time) flexible start and end time (adhered to some period) (Free-time) free organisation of working hours
	Respondents shopping incl.travel (h/day)	time spent in shopping activity and travel (metric)
	Respondents childcare incl.travel (h/day)	time spent in childcare activity and escort (metric)
	Respondents errands incl.travel (h/day)	time spent in household activity and service trips (metric)
Partner interaction	Partner commute distance (km)	partners commute distance (metric)
	Partner shopping incl.travel (h/day)	partners time spent in shopping activity and travel (metric)
	Partner childcare incl.travel (h/day)	partners time spent in childcare activity and escort (metric)
	Partner errands incl.travel (h/day)	partners time spent in household activity and service trips (metric)
Preferences	Preferred work hours	(Traditional) preferred working hours greater than actual working hours versus traditional household pattern (M>F) (Egalitarian) preferred working hours equal to actual working hours versus egalitarian household pattern (M=F) (Reverse) preferred working hours less than actual working hours versus egalitarian household pattern (F>M)

3 Results –Summarised findings between two groups

Figure 2 shows the AME (average marginal effects) for partnered respondents without young children while Figure 3 shows the AME for those with young children. Here, we describe the significant association between predictor variables and mode choice of men and women, and compare between Figure 2 and Figure 3.

Consistent to our expectations, the personal income positively influences both men and women driving compared to other modes. In particular, income levels are highly significant for respondents with young children preferring driving (Figure 3) than those without (Figure 2). Conversely, the other economic attributes such as education, type of economic sector have a negative relationship with the choice of driving over other modes. For respondents with young children (Figure 3), education level has a positive and statistically significant association with men's cycling and walking (by 0.08 and

0.10 respectively), and with women's cycling (0.19). Also, education has relatively large and negative marginal effects on both men's and women's driving (see Figure 3). Such a negative correlation between education and car use has been previously acknowledged in literature (Beckmann et al., 2006; Scheiner 2006; Scheiner and Holz-Rau 2012). In line with Heinen et al. (2013), we found that men (with or without young children) working in non-market sectors are more likely to have high levels of cycle commuting and public transport usage.

Of household attributes, household income and number of cars are significant in predicting the mode choice of both men and women. For respondents without young children (Figure 2), earning more than €4750 per month is positively associated with cycle commuting for both men and women compared to households earning less than €2750 per month. For respondents with young children (Figure 3), the increase in household income significantly increases the probability of women's public transport usage. Least surprisingly, possessing cars strongly increases the probability of commuting by car for both men and women in both groups. Increase in the number of young children are significantly positive for women's walking, with an average predicted increase of 0.09 (Figure 3).

The spatial fixity attributes such as commute distance and spatial environment variables are significant but predict in opposite direction on public transport usage. For instance, longer commute compared to shorter commute distance is positively associated with public transport use, but less cycling and walking for both men and women from the two groups (i.e. with and without young children). Conversely, for the respondents without young children (Figure 2), the living in urban cities is negatively associated with men's public transport usage and women's public transport and cycling. In large urban areas, the difficulties and costs associated with car use could probably reduce its likelihood of driving, whereas, in the semi-urban or rural type settlement, the reduced access to public transport supply could increase the probability of commuting by cars, which is in line with the findings from (Pucher and Buehler 2008; Zolnik 2011).

In terms of temporal fixity attributes, both men and women working in flexi-time work schedule are more likely to commute by public transport (and also walking), and men working in free time working schedule are less likely to do cycle commuting (Figure 2). This may be due to the reason that respondents with flexible working hours may probably have work activity scheduled during non-peak time, and so they may tend to use often public transport compared to respondents with the fixed working schedule. The respondents with the free-time organisation are more likely to enjoy greater work autonomy, as they decide their work schedule. In addition, the social status may probably influence them to prefer cars to other modes.

Of the unpaid activities, the time spent on shopping tends to increase car use over other modes for men and women from both the groups, which is line with findings of Schwanen (2004) (Figure 2 and Figure 3). In addition, the time spent on childcare (both escort and activity) is negatively associated with public transport usage, cycling and walking, but only significant for men (Figure 2). The time spent in household activities and travel increases the probability of women's walking and public transport usage, though the effect for men fails to reach significance (Figure 3).

Partner interaction reveals an interesting pattern. The findings of partner interaction on male respondents confirm that cohabitation, to some extent, reduces men's driving. For the respondents with young children (Figure 3), the partner effect predicts both men's and women's mode choices much better than those without. For instance, the coefficients of the partner's shopping and childcare positively predict public transport usage for both men and women. Also, partner commute distance increases the probability of women's walking but partner's time spent in household errands reduces the possibility of their walking.

In line with our assumption on egalitarian work role preferences, men's (Figure 2) preference of working hours equal to their partners are significantly more prone to cycle commuting than driving, and female partners with egalitarian and reverse attitude (Figure 3) are more likely to walk than driving.
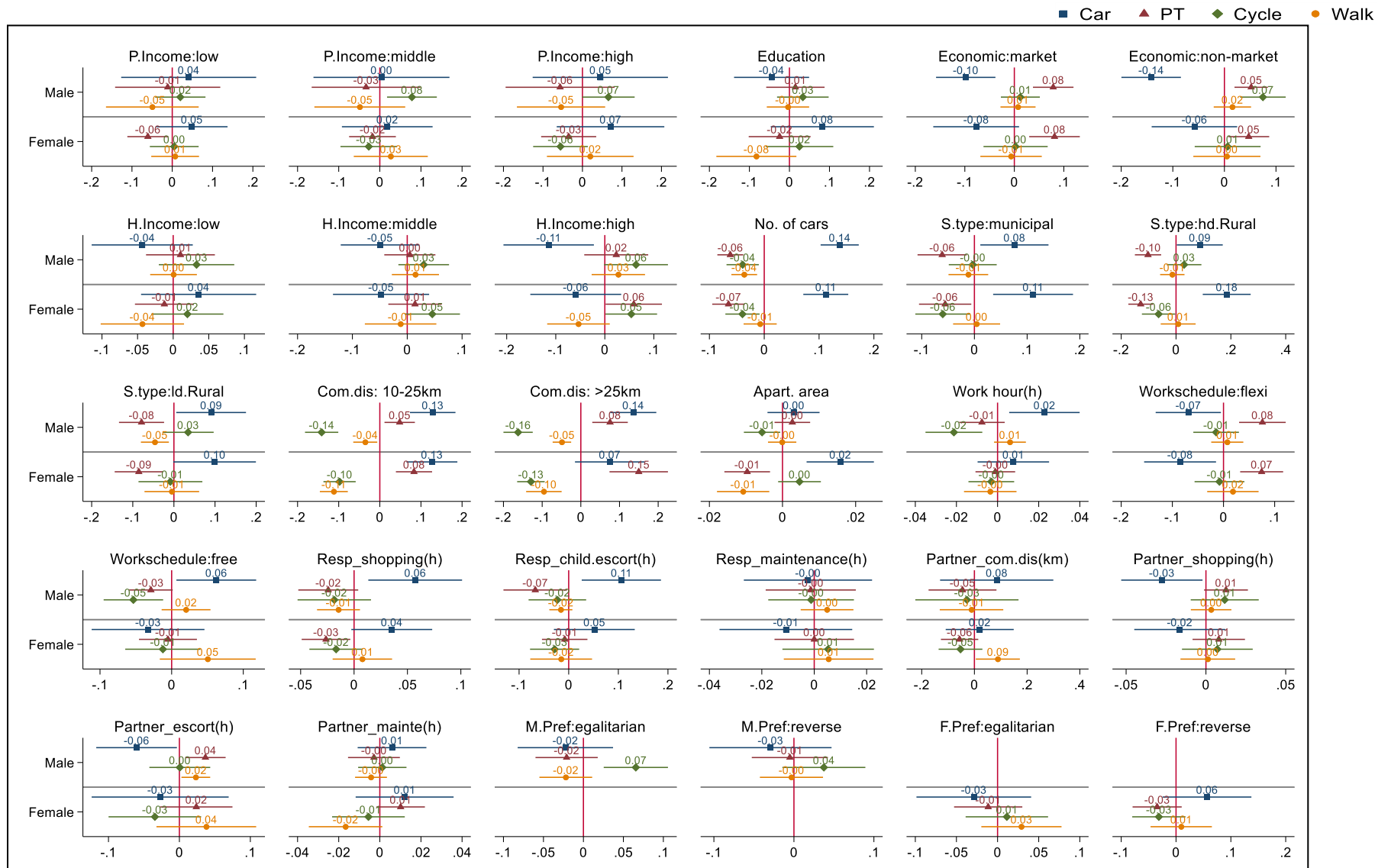
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Figure 2: Average marginal effect of explanatory variables - Partnered respondents (Male and Female) without young children for all four modes
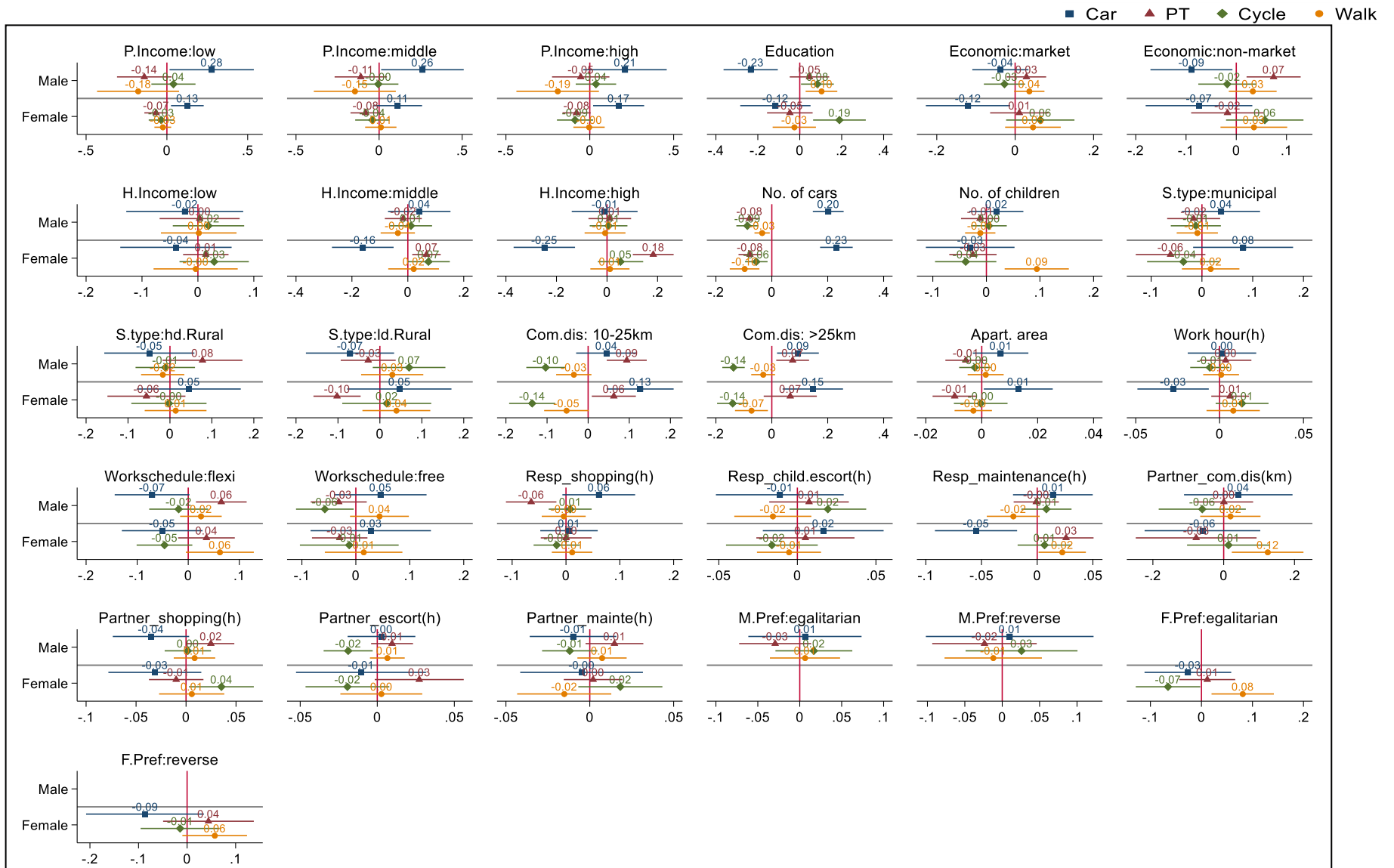
Figure 3: Average marginal effect of explanatory variables - Partnered respondents (Male and Female) with young children for all four modes

4 Conclusions

With our study, we broaden the existing knowledge regarding the work-trip mode choice of men and women in Germany. Comparison of the two groups i.e. partnered respondents with and without children shows that the estimated coefficients of the factors associated with work-trip mode choice are more similar than different between men and women. Also, we found no striking differences in directions of coefficients between the groups except that some variables are more significant for respondents with young children. For instance, the personal socioeconomic status, household attributes, partner variables and work hour preferences strongly influence the work- trip mode choice of partnered respondents with young children. Not to forget, for respondents without young children, besides a few other variables, the spatial and temporal fixity attributes strongly influence the mode choice of men and women. Based on the summary of findings we draw five main conclusions.

First, the increase of personal income increases the probability of driving over other modes, whereas, the increase in level of education, and working in market or non-market economic sector strongly predicts the public transport usage for work trips.

Second, household attributes such as household income and the number of young children positively predict women's' public transport usage and walking. The positive link between household income and public transport usage could be influenced by other household attributes.

Third, except spatial environment and free working schedule, other spatial-temporal fixity variables such as longer commute and flexible working schedule positively predicts the public transport usage for both men and women. This is because the flexible work hours may enable car commuters to switch to public transport as they can adjust their working pattern to suit the schedules. This could hint the transport planning authorities to develop sustainable travel patterns to juggle among homework, childcare and workplace.

Fourth, the effect of intrapersonal interaction, i.e. individual versus partner constraints effects on mode usage is an important finding of this study. Individuals, men, in particular, have increased driving for commuting if they combine shopping or childcare. At the same time, they have increased public transport usage (or decreased driving) if their partners spent time in those unpaid work.

Fifth, the coefficients of work hour preference imply the role they would like to possess within the partnership. Men with egalitarian attitude are more likely to do cycling than driving. Similarly, women with egalitarian/reverse attitude for work hour preference are more likely to walk than driving. This suggest that men/women who prefers to work equally as of their partners, believe in equal values, roles and opportunity, tend to reduce driving and use sustainable modes

Acknowledgement

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