Willingness to Accept Longer Commutes for Better Salaries: Understanding the Differences Within and Between Couples

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Abstract

This paper reports on an analysis aiming to understand differences across individual people in their willingness to accept increased commuting time in return for higher salary, using Hierarchical Bayes (HB) analysis of a dataset collected in Sweden. We find that socio-demographic and attitudinal differences are significant in explaining the variations in values of time for individuals, in particular income, who drives when carpooling and hours worked per week. Additionally we also examine the values of individuals when their choices also impact on the salary and commute of their partner, finding that incomes, income differentials, driving behaviour when carpooling, division of housework and car user decisions significantly explain the values assigned to others and variations in an individual's own values once their partner is affected. The overall richness of the results reflect the benefits that posterior analysis can bring, and highlight the computational efficiency of Bayesian methods in producing such conditionals at an individual level.

Keywords: *Hierarchical Bayes; commute; willingness to accept; group choice; residential choice*

Acknowledgements: The authors would like to acknowledge the comments of four anonymous reviewers whose contribution has substantively improved this paper. All errors remain our own. Stephane Hess acknowledges the financial support by the European Research Council through the consolidator grant 615596-DECISIONS.

Introduction

Commuting Behaviour

Commuting forms a key component of travel behaviour. According to recently published results from the Sydney Household Travel Survey (BTS 2013), 23.3% of all trips made by individuals in Sydney were for commuting or work related purposes, representing almost a quarter of the 16.5 million trips made on weekdays in 2011/12. In 2007 in Sweden, 20% of trips are for the purpose of commuting, down from 30% in 1994 (Borjesson et al. 2012). In the United States, commuting to work constitutes approximately 16% of all person trips and 19% of all person miles of travel. For roadway travel, commuting constitutes 28% of household vehicle miles of travel and, for transit systems, 39% of all transit passenger miles of travel (AASHTO 2013). The United Kingdom reports similar statistics to those in the United States, with 16% of trips being for the purpose of commuting, accounting for 19% of the average distances travelled by people; with a person making an average of 145 commuting trips and travelling an average of 1,279 miles (DfT 2014).

When comparing the length of commuting trips to other types of trip purposes commuters, on average, travel significantly further than any other trip type. In the UK, a recent report by the Office for National Statistics examined the relationship between commuting to work and personal well-being (ONS 2014). They found that, ceteris paribus, commuters have lower life satisfaction, a lower sense that their daily activities are worthwhile, lower levels of happiness and higher anxiety on average than non-commuters. The worst effects of commuting on personal well-being were associated with journey times lasting between 61 and 90 minutes. These findings provide ongoing support for previous work that discovered longer commutes are positively correlated with high blood pressure, higher back pains and lower job satisfaction (Kluger 1998) as well as chronic stress and fatigue symptoms which can induce cardiovascular abnormalities and dysfunctions related to the onset of heart disease (Kageyama et al. 1998).

As both the developed and developing world experience increased urbanisation it is conceivable higher city based populations will contribute significantly to congestion on the roads and crowding on public transportation, and potentially bring into sharper focus the commute decisions of individuals and the recompense required in order to engage in varying types of commuting behaviour. While there is some evidence that telecommuting can decrease the distances travelled (Helminen and Ristimaki 2007), the reductions are only small (0.7%). Indeed, the well-known phenomenon of Marchetti's Constant, seems to indicate that there is an innate human preference for some degree of travel for commuting each day, which is approximately one hour. A study by IBM (IBM 2011) provides support for this, with the average one-way commute across the range of international cities being 32 minutes (with Moscow at 42 minutes and New Delhi at 41 minutes having the longest commute).

Whilst the average commute time might be remarkably constant over time and geographic location, there is a distribution of individuals around that mean who are more or less willing to commute. Not only does this willingness vary across the population, but individuals themselves may also change over time. It has been found that 20% of workers change job or residence each year (Dargay and Hanly 2007). When workers change jobs and/or home or both it is found that just as many increase their commute time as decrease it (Dargay and Hanly 2003). In a small sample study of workers in Bristol in the UK, it was found that half

of those surveyed would be prepared to commute further for a job they wanted, but only a small percentage would be prepared to move house to do so (Mason 2005).

Travel Activity and Household Interactions

Adding further complexity to the travel activity of households is the growth in dual-income households. For example, between 1996 and 2006 the number of dual-income families in America increased 31% (US Department of Labor 2007). Such households have complex trades to make with respect to the balancing of household activities (both social and domestic) as well as the preferences of multiple income earning individuals with respect to where to live and thus how far to travel for work. In responding to a change in employment location for one of the household members, many households choose to avoid moving, to avoid impacting children and the career of the partner whose job has not changed, typically resulting in longer commutes for the partner changing job (Green et al. 1999). There is some evidence that the affected partner views this sacrifice as a gift to their partner (Jain and Lyons 2008).

Given the volume of trips made for commuting purposes, understanding the valuations attached to such trips is important for a range of policy and economic reasons. Lyons and Chatterjee (2008) clearly state that "The commute in connecting the domestic and employment spheres of people's lives is thus a significant feature of life course decisions; notably residential and job location choices", concluding that such decisions significantly impact housing and employment markets. In attempting to understand such choices, the residential and job location choice literature is dominated by models considering a single decision-maker in each household (see Timmermans (2006) for a broad overview of the extant literature), however a small but growing field of research is attempting to understand the behaviour of households. For example, it was found that with respect to residential location, preferences between family members differ substantially and group members are largely unaware of the direction and extent of these differences (Molin et al. 1999). The household attitude to inequalities in utilities among the household members when choosing a residential location has also been explored (Zhang and Fujiwara 2006).

The literature has also examined the role of households in travel activity patterns (which incorporate commuting trips). For example, choices of household activity, assignment of activities and cars to household members, tour generation and assignment affect by individual and household characteristics (Wen and Koppelman 2000). It was found that the activity patterns of individuals were influenced greatly by the activity patterns of others in the household (Vovsha et al. 2004) and that different activities are more likely to be completed jointly on different days or by different household members (Srinivasan and Bhat 2005). With respect to who influences the decisions made by households, husbands exert more influence over the allocation of household activities (Zhang et al. 2005). In an interesting examination of husband and wife trip-timing decisions with respect to the morning commute, De Palma et al. (2015) find that the premium a married couple place on time spent at home together is significant in the choice of departure time and resultant congestion.

For a comprehensive review of the extant literature intra-household interactions reviewers should refer to Ho and Mulley (2015), who note that explicitly accommodating such interactions allows for greater insight into travel behaviour, but understanding of how people may respond to policy, thus the creation of better policy. It should also be noted that the

importance of choices which are a function of interacting decision makers as also been explored in the context of other transport environments such as holiday choice (Dosman and Adamowicz 2006, Beharry-Borg et al. 2009) and automobile choice (Beck et al. 2013), as well as household preferences for water quality (Rungie et al. 2014). The methods used in this paper are aligned with these types of models, where choices from individuals within a household are independently collected and modelled.

Determinants of Household Labour Supply

As commuting choice is linked to employment, it is necessary to also discuss this paper in the context of household labour supply decisions. Within this literature the traditional approach is the "unitary model" whereby each household is treated as a unique decision maker based work the classic economics of the family work by Gary Becker (1965, 1973, 1974, 1991). However, these approaches can result in biased evaluations (Lundberg et al. 1997, Lise and Seitz 2011) because the composition of the household is largely ignored, such as differences incomes between member within a household or differences in the number of children across household (De Palma et al. 2014).

As a result, labour supply models are among the oldest to have incorporated cooperative models such that the presence or absence of egotistical and sharing behaviour can be examined and well-being analysis can be conducted at both the household and individual level (Donni and Chiappori 2011). One of the more widely adopted models of cooperative household labour was developed by Chiappori (1988,1992) wherein it is assumed that household decisions are Pareto efficient but abstracts from the details of the bargaining process. The models discussed in the last paragraph of the previous section build on this cooperative model by incorporating a Nash-type approach where each household member first identifies their most preferred alternative and then the household compromises by averaging along the resulting negotiation frontier.

The corollary here is that there is a strong tradition in applying these models to understand the determinants of household labour supply. For example, applications have shown that the incomes of both spouses, income differentials, work-status, sex role orientations (attitudes or ideology towards gender equality), time availabilities and power relations all significantly determine supply of labour and the division household tasks (Stafford et al. 1977, Perrucci et al. 1978, Model 1981, Kamo 1988). More recent studies have shown that wage growth, decreasing fertility rates and assortive mating (people choose to mate with persons similar to themselves) have led to increases in the supply of female labour sine the 1970's (Bredemeier and Juessen 2013), along with shifts in the cost of children relative to life time earnings (Attanasio et al. 2008). Interestingly in the context of this study, it has been shown that labour force participation rates of married women are negatively correlated with the metropolitan area commuting time (Black et al. 2014).

Many feminist writers suggest that gender relations and traditional normative pressures means that women are assigned the work of the family and work of the home life regardless of employment status (Hattery 2001) and there is a there is a relationship between the increased supply of female labour and the husbands participations in household tasks (Davis and Greenstein 2004). Importantly, research into household chore allocation has shown that an unequal division of household labour is negatively associated with reported marital satisfaction (Frisco and Williams 2003, Greenstein 2009) and as a result of increased

egalitarianism combined with a rising proportion of dual-earner, the relevance of traditional gender specialization has been reduced, leading to an upward trend in female labour force participation (Oshio et al. 2013). With respect to fairness and household decision making, it has been found that decisions made by the partner to make a large personal expenditure or to reduce time spent on household chores were considered as more fair if the outcome was framed as a forgone gain then if it was framed as a straight loss (Antonides and Kroft 2005).

At this point it is important to note that in discussing the results presented later in this paper, we interpret relationships between values of time and household behaviour guided by the tradition of this research. However, while our intuition for the relationships discovered are based on this previous work, along with discussions with colleagues in the area of work and organisational studies, we acknowledge that a deeper exploration of motivations is required to prove if our informed intuition is correct.

Contribution of this Paper

With respect to values of time, particularly with respect to commuting, the aforementioned studies examine either the outcomes of household decisions alone or the way that individuals within the household interact in order to arrive at a consensus choice. While this is crucial to our understanding of transport related behaviour, of equal importance is understanding why individuals might hold the specific preferences they exhibit and how these preferences might change in response to the presence of other people. This is particularly true in the context of choices affecting the commute of individuals within a household, given the social, health and labour market implications of these trips and the important economic function they serve.

Thus, the objective of this paper is to provide an example of how researchers and practitioners might seek to understand how preferences are formed, and how that formation might change when the individual is asked to consider their partner in addition to themselves when making a decision, as well as modelling which provides insight into the values that an individual may assume for their partner. A better understanding of commuting preferences will also allow transport planners to better manage these trips. Specifically, we explore the willingness of couples to accept longer commuting times for an increased salary. To do this we employ a Hierarchical Bayes model to estimate individual level sensitivities from stated choice (SC) data collected in Sweden, thus allowing for inferences about a specific respondent's preferences. The paper is structured as follows. In the next section, we present the data used for our analysis. This is followed in Section 3 by a brief overview of the modelling methodology. Section 4 describes the results of the empirical modelling. Finally, Section 5 provides discussion and concluding remarks.

Survey Data

The case study used in this paper is an examination of salary and travel time trade-offs in the Stockholm region of Sweden. The sample consisted of dyadic households, wherein each member of the household was required to make decisions independently of the other member. Table 1 summarises the characteristics of the sample by gender.

Table 1: Sample Demographics

		Female	Male
Age	Average	40.2	43.2
	Std. Dev	*7.1*	*8.6*
Income/Mth (pre-tax)	Average	22132 SEK	30420 SEK
	Std. Dev	*12099 SEK*	*15047 SEK*
Possess driver's license		90%	97%
Education - No University		46%	41%
Education - University		54%	59%
Commute - Less than 20min		28%	29%
Commute - 20 to 40 mins		42%	39%
Commute - More than 40 mins		30%	32%
Mode - Public transit		21%	29%
Mode - Car driver		45%	25%
Mode - Car passenger		1%	2%
Mode - Car and public transit		2%	2%
Mode - Active transit		5%	6%
Work from home		1%	1%
Full-time employee		65%	94%
Part-time employee		24%	3%
Parental leave		10%	3%

***Note**: Missing values are the reason why percentages do not sum to 1.*[1]

For background information on the data see Swardh and Algers (2009), while a recent application using the data is described in O'Neill and Hess (2014). Because households comprising male/female dyads were sample the gender split is equal and the average household has 1.6 (1.0) children. The average number of vehicles per household was 1.4, with 60 percent of household owning one car and 37 percent owning two or more.

Within the experiment, two different scenarios were administered. The first required respondents to consider the hypothetical scenario that their workplace would be moved to a location that would imply a *longer commuting time* and that this disutility would be compensated by a *higher monthly net wage*. No other commute or household characteristics are varied as part of the choice task. Two levels of each attribute were used in all possible combinations and always pivoted around the respondents' present situation. These levels were an additional 10 minutes or an additional 25 minutes per one-way commuting trip and 500 SEK and 1,000 SEK in net wage per month (at the time of the survey 11 SEK was equal to approximately 1 EUR). An example of the individual choice task is shown in Figure 1.

[1] This question asked each respondent if they took each listed mode of transport daily, 2-3 times per week, 2-4 times per month, less often or never. Looking at the way data was coded, in many instances respondents provided only one response for one or two modes and all other responses were coded as missing. For example, many males stated they took public transport daily and left the remaining modes blank, which were subsequently coded as missing. It is thus likely that the coding strategy explains the otherwise large amount of missing data. Overall, 9 percent of males and 14 percent of females provided no response to the mode of transport question.

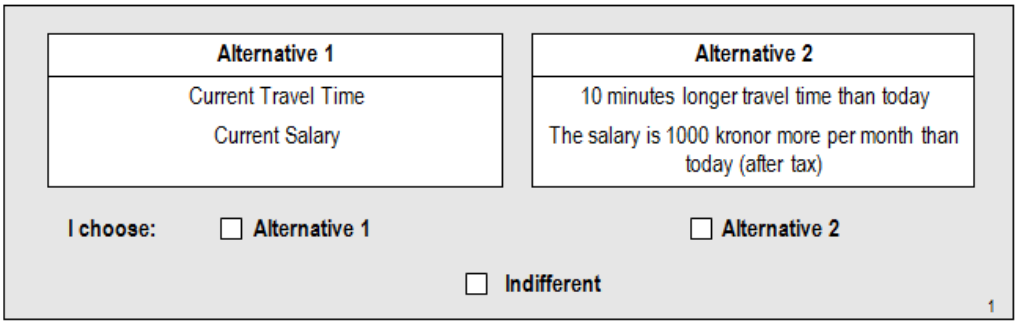

Figure 1: Example of Individual Choice Task

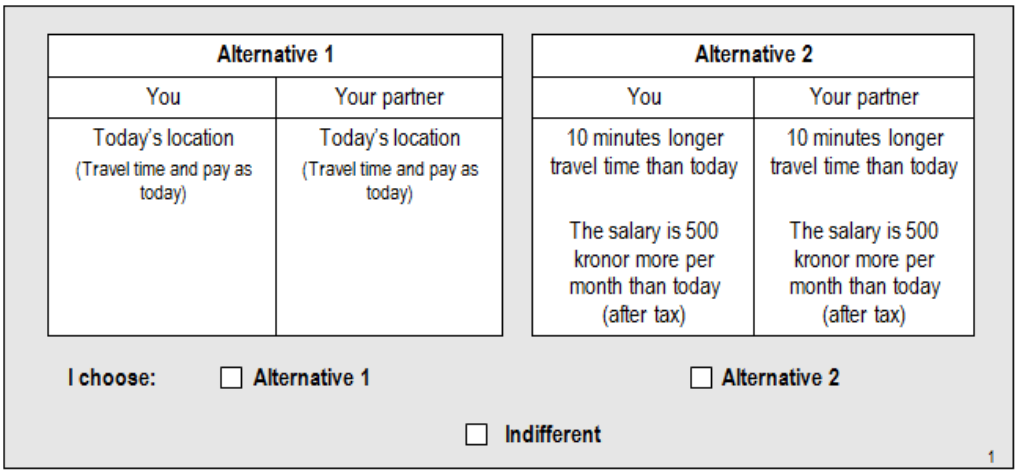

Figure 2: Example of Joint Choice Task

In the second stated choice experiment, the respondents were given choice scenarios where four attributes in each alternative were varied around the current reference situation, under the assumption that the workplace of themselves *and* their partners was relocated. Thus, the attribute varied in this experiment were the respondent's own commuting time and wage, as per the previous experiment, but also the travel time and salary of their partner. An example of the joint choice task is shown in Figure 2.

It should be noted that in both choice tasks, the respondent was asked to "*choose the trip you would really prefer and that suits you best*". Given this instruction, the *a priori* expectation is that if the respondent was maximising their own utility, the impact of the change on the partner would be minimal and the willingness to accept estimates would be similar across both choice tasks. However, if there is an observed difference in the willingness to accept across choice tasks, the change to the partner's travel and salary must be playing a moderating affect in the choice. That is to say, what "suits you best" in the individual choice task may not "suit you best" when your partner is also affected.

A total of 1,179 household couples were included in the sample (creating a pool of 2,358 total respondents). Each respondent was given four scenarios to complete in the first game where only their own commute and salary was varied, and an additional four or five tasks in the second game, depending on the design which was used, where both their own and their partners attributes were changed. It should be noted that males and females within the same household received different versions of the survey. This provided a total of 20.041 choice observations. While the dataset contained 1,179 households, the total number of usable

responses varied slightly around this number based on the completeness of the survey data collected.

A range of contextual information was also captured in addition to the travel times and salaries of each member of the dyad. This included age, driver's license, distance driven by the individual in a year, which partner drives most often when carpooling, level of education, employment status, number of hours worked per week, flexibility of the work schedule, and attitudes about whether respondents agreed if the car was used by the person who needed it most, that car user decisions are made equally, that housework is divided equally and that females are safer drivers. These variables were used to explain variations in the willingness of respondents to spend more time commuting in order to earn a higher salary.

Methodology

To gain a deeper understanding of preferences at the individual levels, we used Hierarchical Bayes (HB) estimation of Mixed Logit models. For a detailed discussion of Bayesian techniques for Mixed Logit, see (Train 2009). Hierarchical Bayes used Bayesian estimation of a Mixed Logit model. As with a standard Mixed Logit model, a sample level assumption is made about the distribution of sensitivities across respondents, but priors for the parameters of the distributions are additionally provided for estimation. These distributions are then updated using an iterative process, in our case "Gibbs Sampling". HB estimation does not "converge" like classical estimation, but the analyst needs to make a decision of how many iterations of the Gibbs sampling to use. In our case, we used 50,000 burn-in iterations and averaged results over 10,000 values after the burn in iterations, obtained by using every second iteration out of 20,000. An analysis of the Markov chains showed stable values after a low number of iterations, as expected with such a simple model specification and large sample.

Additionally, we tested the stability of the final 10,000 iterations using Geweke's Diagnostic (Geweke 1992), wherein the mean of the first 10% is tested against the mean from the last 50% and if the difference is not significant it can be concluded that the target distribution converged somewhere in the first 10% of the chain. The results are as follows, with the Geweke z values in brackets: female own (z = 0.452), male own (z = 0.713), female own in joint (z = 1.748), male own in joint (z = 1.069), female assign to partner (z = 0.067), male assign to partner (z = 1.847).

The advantage over classical estimation is primarily computational when it comes to dealing with models with correlated coefficients. The outputs from HB estimations are an upper level model, which is the *unconditional* model (similar to sample level estimates in a classical model), and conditional distributions at the person level (like posteriors from a classical model). HB estimation produces conditional (posterior) distributions of sensitivities at the individual respondent level. These are analogous to conditional distributions obtained from Mixed Logit using classical estimation (cf. Daly et al. 2012).

In the present analysis, we are interested in understanding the differences across individuals in their willingness-to-accept (WTA) increases in commuting time in return for increases in salary. This WTA is clearly given by the ratio of two marginal sensitivities, say:

$$WTA = -\beta_T/\beta_S \quad [1]$$

obtained from a model with a utility function for alternative *i,* respondent *n* and choice task *t* given by:

$$U_{int} = \beta_T TT_{int} + \beta_S S_{int}, \quad [2]$$

where TT_{int} and S_{int} give the travel time and salary for alternative *i* as shown to respondent *n* in choice task *t*.

With β_T and β_S both following random distributions across respondents in [2], the WTA in [1] is given by a ratio of two random coefficients. To avoid this issue, we instead parameterise our model directly in WTA space, rewriting [2] as:

$$U_{int} = \beta_T TT_{int} - \beta_T \beta_{WTA} S_{int}, \quad [3]$$

where it can easily be seen that [2] and [3] are equivalent when β_{WTA}=WTA as in Equation [1]. This in turn means that the posterior means at the individual level from the distribution of β_{WTA} can be used as the most likely value of the WTA for a given respondent. We experimented with various different distributional assumptions for β_T and β_{WTA} but settled on Normal distributions as giving the best performance in the end, with the exception of the WTA of males in the individual tasks which was specified as Log-Normal. All the individual level posterior means for both β_T or β_{WTA} were of the expected sign and the issue of division by a normally distributed random coefficients (cf. Daly et al. 2012) does not arise as the division in [1] is not required when working directly in WTA space.

Results

Exploring the Willingness to Accept Values

The HB estimation procedure resulted in individual level mean willingness-to-accept values (WTAs) for both males (MO) and females (FO) in the individual choice games, but also the individual WTAs when asked to consider changes to their partners commute and salary as well as their own (FOG: female WTAs in the group choice and MOG: male WTAs in the group choice). On average, both males and females were prepared to travel an additional 11.8 minutes an increase in salary by 1,000SEK (*t = 0.159*). As can be seen in Figure 3, females exhibit a much larger variation in WTAs. Both distributions appear to be bimodal though a greater proportion of woman are prepared to accept much longer trips for salary increases than males, the long right tail for females indicating that a sizeable proportion have quite high WTAs.

Figure 4 compares the distributions of WTAs in the joint task (where the respondent had to consider the changes to their partner as well as their own situation). In these tasks, the willingness to accept a longer commute was lower. On average females would travel 7.7 minutes, compared to 6.3 minutes for males, with this difference being significant (*t = 35.063*). Interestingly, both males and females decrease their WTA by the same amount (approximately 4 minutes), such that the differences between the individual. That is to say, males and females have different individual preferences, but both genders revise their WTAs

similar amount, such that the relative difference is maintained between the initial independent WTAs is maintained in the joint choice (albeit at a lower level).

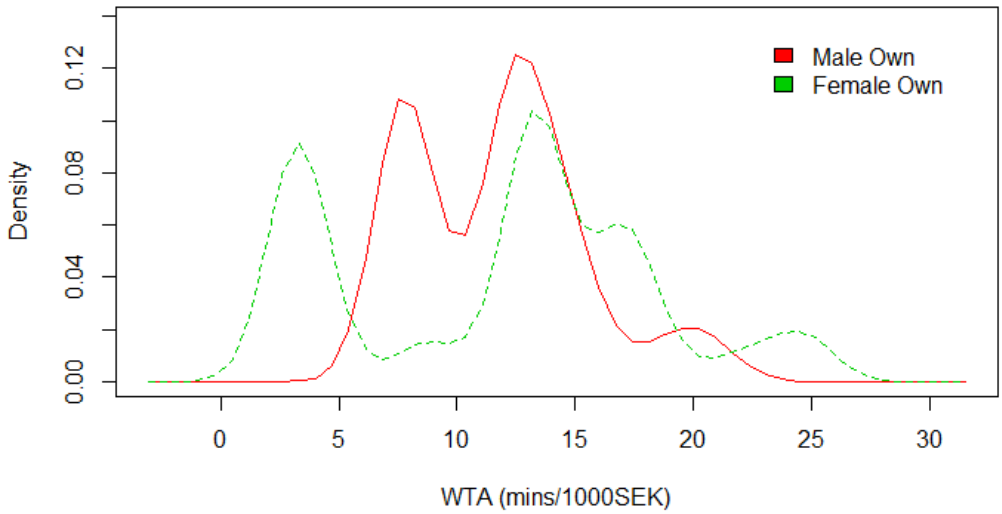

Figure 3: Distribution of Female and Male Own WTAs

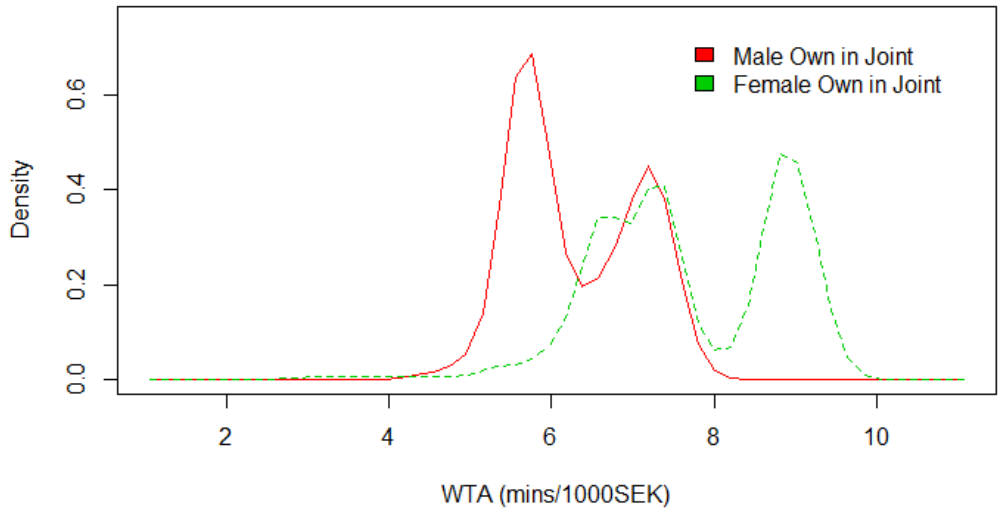

Figure 4: Distribution of Female and Male Own WTAs in the Joint Task

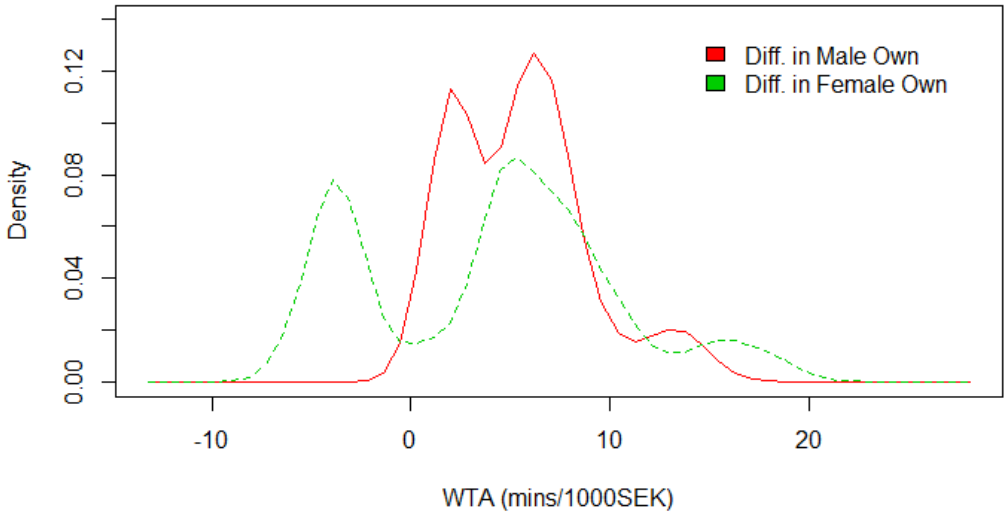

Figure 5: Distribution of Differences in WTAs (Own compared to Own in Joint)

Another interesting finding highlighted in Figure 5 is that while males, on average, reduce their WTA by 4 minutes, all males revise their WTA downward when moving from choices that involved changes to their own commute to choices where the commute of the partner is also affected. This is in contrast to females. While the majority of females also revise their WTA down when asked to make choices where their partner is affected, 30% of the sample *increased* their WTA. In other words, they made choices that indicated they themselves would be prepared to travel further for an increased salary. Again, the distribution for differences between the two games for females is distinctly bimodal indicating two very different types of behaviours, with females in general exhibiting a wider range of different behaviours than males when it comes to adjusting their own WTA. Correlation analysis reveals a significant and positive relationship ($r = 0.486$) between the WTAs of males in the individual game and the joint game, indicating that males who have a higher WTA as individuals, also have a higher personal WTA when also considering changes to their partners commute. This is also true for females though the relationship, whilst still significant, is weaker ($r = 0.252$).

In the context of the choice task where respondents were required to make a choice that affected not only themselves but also their partner, they are prompted to make a choice that *suits the respondent best*. Given this instruction there are three possible ways in which respondents processes the choice task:

1) They make a choice that is strictly best for them.

2) They make a choice that is best for their partner.

3) They make a choice that is best for the household overall.

Implicit in all of these choices is the assumption that respondents assign their partner a WTA value; either a value that they think best represents the willingness of their partner to engage

in longer travel for higher pay, or that best represents what they think their partner should accept such is what is best for the respondent or for the household. In practice, a mixture of all of these responses is likely to arise. Without any further information, such as relevant attitudinal data or details on the decision making mechanism used by respondents to make a choice, it is not possible to definitively state why any observed differences that may exist between the WTA values that a respondent assigns to their partner in the joint task and they values their partner expresses themselves. An interesting avenue of future research would be to seek out the different approaches used and which individuals act in which manner.

Independently of the interpretation, there are thusly four total comparisons of interest; the WTA that females assign to their partner (FP) and their partner's actual WTA as an individual decision and a decision in the joint task (MO and MOG). The same is also true for males; the WTA assigned to their partner (MP) and their partner's actual WTAs (FO and FOG).

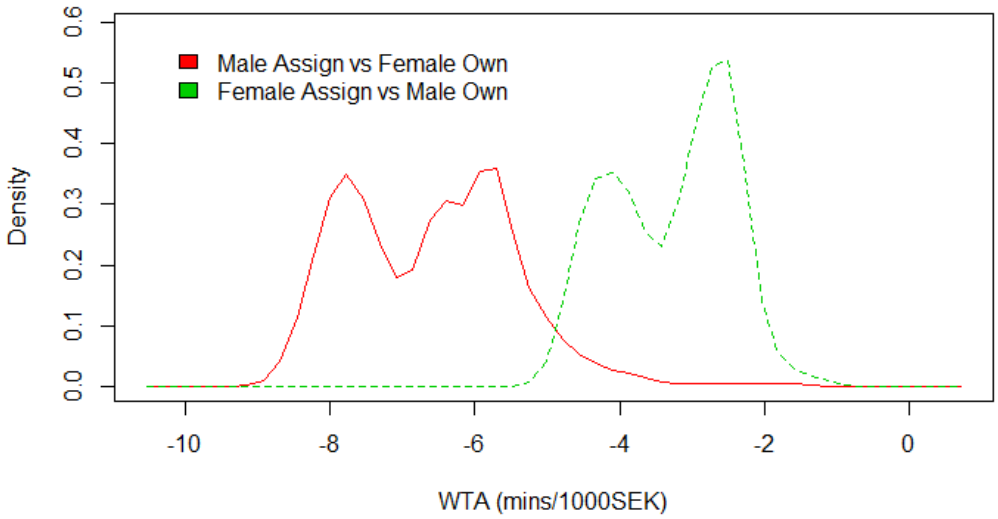

Figure 6: Distribution of Differences in Assigned WTA (Assigned compared to Actual in Joint)

In all instances, the WTA each gender assigns to their partner is lower than either the WTA expressed by their partner in individual decisions or expressed by their partner in choices made in the joint task. Indeed, every respondent in the sample makes choices that imply a lower WTA for their partner than for what their partner actually exhibits. With the own WTA being lower in the joint tasks than single tasks, the WTAs assigned by a person to their partner are closer to the WTAs that the partner expressed in the joint task himself or herself. The difference in the WTAs for a respondent assigned to them by their partner compared to the WTAs they exhibit themselves is shown in Figure 6. On average, males understate the WTA of their partners by 6.6 minutes compared to 3.3 minutes for females. This results indicate that while both males and females assign significantly lower WTAs to their partner then the actual values ($t = 193.673$ and 137.023 respectively), females give WTAs closer to those revealed by the respondents themselves ($t = 79.990$). There is a very significant and very strong positive correlation between the WTAs males expresses in the joint task and the WTA they assign to their partner ($r = 0.955$), indicating that the higher a male's WTA, the higher the WTA they assign to their partner. On the other hand, almost the exact opposite is true for females. The higher a female's own WTA in the joint task, the lower the WTA they assign to their partner ($r = -0.951$).

Explaining the Willingness to Accept Values

Six regression models were constructed to explain the WTA values observed in the data. The socio-demographic and attitudinal covariates introduced in Section 3 were regressed on the WTAs estimated for females and males from the choice tasks involving changes to only their own commute and salary; the female and male own WTAs estimated from the joint task and the WTA's that females and males assign to their partners. For ease of reference, the variables included in the regression modelling are presented in Table 2.

Table 2: Explanatory Variables

Current salary
Salary relative to partner (higher / lower / same (base))
Current travel time
Travel relative to partner (longer / shorter / same (base))
Age
Number of cars in household
Number of children in household
Driver license status
Years license held
Miles driven in a year
Role when carpooling
Level of education
Level of employment
Days worked / week
Hours worked / week
Distance to work (km)
Work flexibility
Car is used most by person who needs it
Car user decisions are made equally
Generally housework is divided equally
Women are safer drivers

If a variable is not reported in the following tables it means it was not significant in explaining variations in the willingness to accept. In all instances, the respondent's own characteristics were used as well as those of their partner. Table 3 provides the results from the regression on the respondents' own WTA, where the coefficients have been ordered based on relative impact on the dependent variable (largest to smallest).

Table 3: Regression Models: Female and Male Own WTA

Model	*Variable*	*Beta*	*Std. Error*	*t*
Female Own $R^2 = 0.240$ S.E Est = 5.725 F = 10.735	(Constant)	10.769	1.914	5.627
	Salary (f)	-0.0001	0.000	-4.479
	Carpool (m) – Often Me	-2.450	0.756	-3.239
	Male Travels Longer	2.293	0.560	4.093
	Travel Time (m)	-0.005	0.012	-4.328
	Kilometres Driven / Yr (f)	-0.0001	0.000	-4.483
	Carpool(f) – Often Partner	1.751	0.653	2.680
	Hours Worked / Wk (f)	0.122	0.032	3.756
	Salary (m)	-0.00004	0.000	-2.804
	Education (f) – Primary School	-3.272	0.928	-3.527
	Male Salary Higher	-1.473	0.611	-2.409
	Kilometres Driven / Yr (m)	0.00006	0.000	3.238
	Work Flex. (f) – Other	5.682	1.713	3.318
	Days / Yr Commute Made (f)	0.232	0.076	3.066
	Distance (f) – Never	1.326	0.479	2.770
	Housework Equally Divided (f)	-0.486	0.183	-2.658
	Carpool (f) – Often Me	2.756	1.049	2.627
	Carpool (m) – Always Me	-1.637	0.767	-2.134
	Female Travels Longer	1.161	0.568	2.046
	Female Salary Higher	-1.409	0.690	-2.042
	Carpool (f) – Always Me	3.497	1.610	2.172
	Car Decisions Equal (f)	0.470	0.225	2.090
	Women Safer Drivers (f)	0.357	0.170	2.096
	Work Flexibility (f) – Shift	1.263	0.673	1.878
	Work Flexibility (f) – Fixed	0.745	0.450	1.656
Male Own $R^2 = 0.211$ S.E Est = 5.749 F = 11.687	(Constant)	11.360	1.808	6.285
	Salary (f)	-0.0001	0.00002	-4.596
	Travel Time (m)	-0.058	0.011	-5.062
	Salary (m)	-0.00005	0.00002	-3.195
	Hours Worked / Wk (f)	0.128	0.032	3.975
	Male Travel Longer	1.770	0.462	3.834
	Kilometres Driven / Yr (f)	-0.0001	0.00003	-4.022
	Carpool (m) – Often Me	-1.599	0.624	-2.562
	Male Salary Higher	-1.546	0.611	-2.531
	Employ Status (f) – Full-time	-3.267	0.926	-3.529
	Carpool (f) – Often Partner	1.401	0.636	2.203
	Work Flexibility (m) - Other	5.521	1.708	3.233
	Days / Yr Commute Made (f)	0.227	0.076	2.988
	Kilometres Driven / Yr (m)	0.00006	0.00002	2.996
	Housework Equally Divided (f)	-0.524	0.183	-2.863
	Carpool (f) – Often Me	3.036	1.029	2.949
	Female Salary Higher	-1.517	0.691	-2.194
	Distance (f) – Never	1.163	0.478	2.435
	Carpool (f) – Always Me	4.089	1.602	2.553
	Women Safer Drivers (f)	0.410	0.169	2.422
	Car Decisions Equal (f)	0.499	0.225	2.219
	Work Flexibility (f) – Shift	1.286	0.673	1.911

The variable with the biggest impact on female WTA is their own salary, specifically females with higher salaries reporting lower willingness to accept values. Females whose partner states that he is the person who drives *most often* when carpooling also report a lower willingness to accept a longer commute. Females who commute for less time than their partner report higher willingness to accept values. Females whose partner has a longer travel time relative to other males have a lower WTA. Females who drive more per year, whose partner has a higher salary, who have only a primary school education, have a lower salary relative to their partner (compared to households where the salary is the same), always drive

when carpooling with their partner, and who have a higher salary relative to their partner (compared to households where the salary is the same) all report lower willingness to accept a longer commute for more income.

On the other hand, females who work more per week, whose partner drive further per year, have flexible work conditions, commute more days per year, travel longer than their partner or always drive when carpooling have higher WTAs. A number of attitudinal variables are also significant; females who agree that housework is divided equally have lower WTAs and females who agree that car user decisions are made equally and that females are safer drivers have a higher WTA.

With respect to the WTAs of males, men with partners on higher salaries, men who commute for longer periods of time and have higher incomes have a lower willingness to accept a longer commute for more pay. The more hours their partner works and/or if the commute time of the male is longer than their partner, the higher the willingness to accept a longer commute. Interestingly, the attitudes of their partner plays a significant role in the willingness to accept value expressed; men with partners who agree that housework is divided equally have a lower willingness to accept a longer commute, whereas men whose partner agrees that women are safer drivers and that decisions about use are made equally have are more willing to accept a longer commute.

Table 4 presents the drivers of an individual's willingness to accept values that are determined from the joint task. The first thing to note is the reduced number of variables that explain the values exhibited. In particular, we note that very little is explained about the drivers of the WTA of females in the joint task. At this point, it is worth repeating the finding that the WTAs in the joint task are significantly correlated with the WTAs in the individual commuting decision, but the correlation is much weaker for females than it is for males.

Table 4: Regression Models: Female and Male Own WTA in Joint Task

Model	*Variable*	*Beta*	*Std. Error*	*t*
Female Own (Joint Task) $R^2 = 0.026$ S.E Est = 1.127 F = 6.269	(Constant)	7.851	.123	64.012
	Salary (f)	-0.00001	.000	-4.146
	Carpool (m) – Always Partner	-.421	.190	-2.214
	Have License (f)	.246	.120	2.048
	Carpool (m) – Often Me	-.144	.073	-1.972
	Work Flexibility (f) – Shift	.202	.098	2.058
Male Own (Joint Task) $R^2 = 0.143$ S.E Est = 0.698 F = 12.718	(Constant)	5.698	.218	26.135
	Salary (m)	-0.00009	.000	-6.656
	Hours Worked / Wk (f)	.019	.005	3.908
	Salary (f)	-0.00009	.000	-3.974
	Employ Status (f) – Part-time	.173	.077	2.248
	Education (m) – Primary School	-.253	.090	-2.823
	Car Use by Need (f)	.061	.022	2.854
	Education (f) – Other	.367	.136	2.702
	Employ Status (m) – Other	1.029	.409	2.517
	Education (m) – Other	.673	.287	2.342
	Work Flexibility (f) – Fixed	.096	.052	1.841
	Years held License (m)	.005	.003	1.799

With respect to the WTA of females, females who earn more have a lower willingness to commute in the joint task, females also have a lower willingness if their partner states that it

is the woman who *always* drives when carpooling or if they (the male) drive *most often* (compared to the base of an equal split). Females who have a license have a higher WTA in the joint task than those who do not, as do females who have shift/schedule work relative to other types of employment. The willingness to accept longer commutes for higher pay is lower for males who have a higher salary and whose partner has a higher salary. Conversely, males whose partner works more hours per week, or whose partner works part-time will accept longer commutes. Interestingly, males whose partner agrees with the statement that the car is used by the one most in need of it have higher WTAs.

Finally, Table 5 provides the results for the WTAs that the respondents assign to their partners in the joint task. Again, compared to their personal WTAs from the individual choice task, the number of factors that explain these assigned WTAs is greatly reduced and the ability of the data to explain the WTAs that females assign to their partners is limited. In this instance though, the assigned WTAs are *very strongly* correlated (indeed almost perfectly correlated) with the willingness of the individual themselves to commute for longer periods for increased pay. In the case of females, the higher their own willingness to commute the lower the WTA they assign to their partner. The opposite is true for males, with males who have a low (high) willingness to accept longer commutes assigning similarly low (high) willingness to their partner.

Table 5: Regression Models: Female and Male WTA Assigned to Partner

Model	*Variable*	*Beta*	*Std. Error*	*t*
Female Assign to Partner $R^2 = 0.021$ S.E Est = 0.253 F = 4.981	(Constant)	-3.049	0.033	-93.192
	Male Salary Higher	-0.049	0.020	-2.476
	Salary (f)	0.000002	0.000	2.786
	Female Salary Higher	-0.062	0.024	-2.524
	Carpool (m) – Always Partner	0.121	0.043	2.811
	Carpool (m) – Often Me	0.036	0.016	2.191
	Years held License (f)	-0.057	0.027	-2.109
Male Assign to Partner $R^2 = 0.143$ S.E Est = 0.299 F = 12.723	(Constant)	0.849	0.100	8.484
	Salary (m)	-0.000005	0.000	-6.834
	Salary (f)	-0.000003	0.000	-3.216
	Age (m)	0.005	0.001	3.397
	Hours Worked / Wk (f)	0.005	0.002	2.904
	Education (f) – Other	0.167	0.054	3.077
	Education (m) – Primary	-0.106	0.039	-2.752
	Carpool (f) – Always Partner	-0.082	0.033	-2.455
	Female Salary Higher	-0.060	0.033	-1.794
	Carpool (m) – Often Partner	-0.101	0.051	-1.977
	Car Decisions Equal (f)	0.020	0.011	1.871
	Car Use by Need (f)	0.016	0.010	1.684

Females who earn less than their partner (relative to those who earn the same) assign a lower willingness to accept value to their partner, as do females who earn more than their partner (versus those who earn the same). Females on higher incomes assign a higher WTA to their partner, as do those whose partner states that the female *always* drives when carpooling. Females who have held a license for a longer time assign a lower WTA. Males with a higher salary and males whose partners have high salaries assign lower WTAs to their partners. Conversely, older males, males whose partner works more hours per week and whose partner has an education level other than primary school, high school or university assign higher WTAs to their partner. Males in households were the female earns more assign their partner a

lower WTA. The attitudes of their partner also impacts on the willingness to commute values that males assign to their partner. Males whose partner agrees more with the statements that car user decisions are made equally and that the car is used by the one who needs it most, assign a higher WTA to their partner. One interesting thing to note in Table 5 relative to Table 4 is that the relative differences between the salaries each person within the household are significant in explaining the WTAs assigned by a person to their partner, but not in what WTA they reveal for themselves.

Explaining the Differences in Willingness to Accept Values

An additional benefit of having individual specific mean WTA measures is that it enables an exploration of the differences that exist in these values. In this data, we observed significant revision of a respondent's willingness to accept in the joint task compared to what they stated in the individual task where they were considering choices where only their own commutes and salaries were varied. Table 6 provides the results of regression analysis that was conducted to uncover the drivers of these preference revisions.

The dependent variable in the models presented is the difference between the WTAs in the joint task minus the WTAs in the individual task. In the case of males, all these values were negative, indicating that WTAs in the joint task were lower than in the individual task, in other words the WTAs for males were lowered when the partner was affected by the choice. Positive coefficients in the regression model indicate smaller differences between the WTAs whereas negative coefficients indicate that the downwards revision was larger. Males on higher salaries revise their preferences less than males on lower incomes. Males who state that their partner *always* drives when they carpool and males whose partner works more hours per week reduce their WTA by a larger amount. Attitudes are important in explaining how much males revise their willingness to commute; males whose partner agrees that housework is divided equally reduce their WTA less, as do males who agree that females are safer drivers.

With respect to the differences exhibited in the female willingness to accept longer commutes for increases in salary, recall that it was observed that while most females similarly lower their WTA in the joint task, a sizeable minority increased their WTA. That is to say, unlike males, some females were willing to commute for longer in order to secure an increased salary in the scenarios where the commutes and salaries of their partners were affected by their choices. Though there are only a handful of significant variables, a relatively high amount of the downwards revision of the WTAs expressed by females can be explained. Among the females who lower their WTA in the joint task, females with higher salaries reduce their WTA by larger amounts (in contrast to males where the opposite is true). Similarly, females who state that they drive *most often* when carpooling and females who agree with the statement that car use decisions are made equally reduce their WTA more. Females who earn more than their partner or who are in households with a higher number of cars revise their willingness to accept less, as do females who agree that car user decisions are made equally and that women are safer driver.

Interestingly, among females who increase their willingness to commute, those on higher salaries increase their WTA more than those on lower salaries. Women who agree that housework is equally divided also increase their WTA more, whereas those whose partners agree with this statement increase their WTA less. Older females increase their WTA less as

compared to younger females, females whose partner states that the female *always* drives when carpooling and females who work more hours per week increase their willingness to commute less than others. Females who travel longer for their commute compared to their partner also express a higher willingness to commute in the joint as compared to the value in the individual choice task. A result worth highlighting is that among females who increase their WTA, those whose partners spend more time commuting increase their own WTA more in the joint task. This is the only instance in which the partner's current salary or travel time influence the preferences exhibited by either males or females.

Table 6: Differences in Preferences: Own in Joint Task minus Own

Model	*Variable*	*Beta*	*Std. Error*	*t*
Male (Own-Joint vs. Own) $R^2 = 0.251$ S.E Est = 2.774 F = 13.517	(Constant)	-6.684	0.993	-6.729
	Carpool (m) – Always Partner	-8.846	1.781	-4.966
	Salary (m)	0.00004	0.000008	4.882
	Hours Worked / Wk (f)	-0.093	0.020	-4.559
	Salary (f)	0.00003	0.00001	2.826
	Carpool (f) – Often Me	-1.623	0.675	-2.404
	Work Flexibility (m) – Shift	-1.479	0.511	-2.892
	Carpool (f) – Always Me	-3.358	1.184	-2.837
	Work Flexibility (f) - Shift	-1.063	0.403	-2.637
	Women Safer Drivers (m)	0.289	0.109	2.648
	Work Flexibility (f) – Fixed	-0.643	0.293	-2.200
	Housework Divided Equally (f)	0.236	0.109	2.174
Female WTA Down (Own-Joint vs. Own) $R^2 = 0.403$ S.E Est = 0.780 F = 19.689	(Constant)	3.756	0.363	10.342
	Salary (f)	-0.00003	0.000	-10.095
	Car Decisions Equal (m)	0.197	0.064	3.064
	Carpool (f) – Often Me	-0.822	0.286	-2.876
	Female Salary Higher	0.365	0.143	2.555
	Distance (f) – Always	-1.229	0.569	-2.159
	Women Safer Drivers (m)	0.084	0.042	2.008
	Car Decisions Equal (f)	-0.094	0.057	-1.660
	Number of Cars in Household	0.132	0.079	1.678
Female WTA Up (Own-Joint vs. Own) $R^2 = 0.145$ S.E Est = 3.781 F = 7.270	(Constant)	-6.140	1.565	-3.922
	Salary (f)	0.00008	0.000	4.534
	Housework Divided Equally (m)	-0.573	0.151	-3.803
	Housework Divided Equally (f)	0.505	0.154	3.276
	Age (f)	-0.078	0.022	-3.612
	Work Flexibility (m) – Other	-4.210	1.306	-3.223
	Carpool (m) – Always Partner	-2.614	0.849	-3.081
	Education (f) – Other	-2.387	0.807	-2.959
	Hours Worked / Wk (f)	-0.054	0.024	-2.291
	Car Decisions Equal (m)	0.393	0.160	2.452
	Travel Time (f)	0.016	0.007	2.246
	Work Flexibility (m) – Fixed	-0.710	0.322	-2.205
	Distance (f) – Always	4.245	1.948	2.179
	Days / Wk Commute Made (f)	0.680	0.327	2.082
	Travel Time (m)	0.016	0.008	1.927
	Female Travels Longer	0.604	0.306	1.975

Finally, Table 7 reports the models estimated to explain the differences that exist between the actual willingness to accept displayed by individuals in the choice task versus those that were assigned to them by their partner. In every instance for both males and females, the stated WTA in the joint task is higher than that assigned to them by their partner. In other words, there is a systematic difference in how a person values the time of their partner versus the value that person puts on it; specifically a person assumes that their partner is more willing to

accept a longer commute than that person actually states that they are.[2] The differences modelled in Table 7 are the individuals WTA in the joint task minus the WTA assigned to them by their partner, as this number is always positive, a positive regression coefficient represents a larger difference between the WTAs.

Table 7: Differences in Preferences: Own in Joint Task minus Assigned by Partner

Model	*Variable*	*Beta*	*Std. Error*	*t*
Male Own-Joint vs Assigned $R^2 = 0.162$ S.E Est = 0.741 F = 10.489	(Constant)	2.599	.244	10.640
	Salary (m)	-0.00001	.000	-7.102
	Hours Worked / Wk (f)	.021	.005	3.826
	Salary (f)	-0.00001	.000	-4.679
	Employ Status (f) – Part-time	.260	.086	3.040
	Car Use by Need (f)	.073	.023	3.147
	Carpool (f) – Often Partner	.153	.053	2.896
	Days / Wk Commute Made (f)	.180	.065	2.771
	Education (f) – High School	-.160	.060	-2.659
	Days / Wk Commute Made (m)	-.131	.053	-2.478
	Years License Held (m)	.007	.003	2.143
	Work Flex. (m) – Shift	-.236	.109	-2.167
	Work Flex. (m) – Other	.669	.307	2.178
	Employ Status (f) – Parent Leave	.182	.093	1.952
	Work Flex. (f) – Fixed	.109	.057	1.924
	Education (m) – Primary School	-.191	.099	-1.923
Female Own-Joint vs Assigned $R^2 = 0.032$ S.E Est = 1.135 F = 5.202	(Constant)	7.000	0.121	58.013
	Carpool (m) – Always Partner	-0.803	0.335	-2.395
	Carpool (f) – Always Me	-0.785	0.330	-2.382
	Salary (f)	-0.000007	0.000	-2.583
	Female Salary Higher	0.238	0.092	2.602
	Work Flex. (m) – Fixed	-0.172	0.073	-2.354
	Number of Cars in Household	-0.132	0.056	-2.347
	Employ Status (m) – Other	-1.052	0.469	-2.243

Looking at the estimation of the male WTAs by their partner, for males who earn higher incomes there is less difference in their own WTA compared to those assigned to them. Likewise, females who earn higher incomes assign a WTA to their partner that is closer to their partners actual WTA. Females who work more hours per week, who are employed part-time, who agree that the car is used by the one most in need of it, or whose partner drives *most often* when carpooling provide WTAs for their partner that are less aligned than the actual WTAs.

The differences between the WTAs of females in the joint task and those assigned to them by males are relatively poorly explained by the covariates collected in the survey. Males who state that their partner *always* drives when they carpool provide a WTA for their partner which is more aligned with the WTA that partner expresses. Similarly males whose partners have a higher salary, who are on a fixed work schedule, or who have a larger number of cars in the household provide WTA for their partner which are closer to the WTA values their partner reveals. On the other hand, males whose partner earns more than them or whose partner states that they *always* drive carpooling provide a WTA that is smaller than the one expressed by their partner.

[2] A higher willingness to accept value indicates that a higher payment is needed to get that person to accept the longer commute. In other words, people with higher WTA values are less willing to experience a longer commute.

5. Discussion and Conclusions

This paper has reported on an analysis aiming to understand differences across individual people in their willingness to accept increased commuting time in return for higher salary. In the context of this experiment respondents were asked to choose between their current commute and alternative workplace location that was further away but offered higher pay. Crucially, we have not just studied differences between male and female respondents and the impact of other key socio-demographics, but also the differences between valuations obtained in choices where respondents are faced only with their commute only and those where they make decisions jointly for themselves and their partner. The inclusion of these latter choice scenarios has also allowed us to study how a person's own preferences might be affected when making choices jointly for both members of a couple.

The analysis has revealed a rich set of findings. We observe major differences between males and females in their preferences for commuting. For females the two variables that have the biggest relative impact on willingness to accept longer commutes are their partner driving most when carpooling and their salary. For males the biggest influence is the salary of their partner, their own salary and the length their current commute. Interestingly, our analysis makes it evident that the distribution of willingness to accept is more disparate for females than it is for males (see Figure 3), indicating that heterogeneity in commuting preferences is larger for females, perhaps reflective of the typically greater diversity in household roles that females often perform. From a policy perspective, decision makers should be aware that the commuting decision is less uniform for females relative to males.

Our research also shows that when asked to consider a change to their partner's commute as well as their own, the willingness of individuals to accept a longer commute change significantly. All of the males sampled become less willing to accept longer commutes if their partner is affected. As with individual preferences, females once again display more heterogeneous preferences (see Figure 5). While the majority also become less willing to accept longer commutes if their partner is also affected, a significant minority become more willing to commute for longer periods of time. Knowing that females are seemingly more altruistic than males when it comes to household commuting decisions needs to be understood by policy makers in the context of household preference formation for commuting decisions.

Interestingly, the correlations between the willingness to accept a longer commute when the choices involved changes to just their own journey and the willingness expressed when making choices where a partner is also affected are only weak. This indicates that the change from the individual result to the joint result is not a simple scaling of values up or down (which would result in a strong correlation), rather the changes vary from individual to individual in a way that is not consistent implying that the revision of preferences is a more complex function of household behaviour, attitudes and demographics.

This approach also enables the policy maker to examine why preferences are revised. In the case of males, the biggest determinant of changes in willingness to accept is their own salary with males on higher incomes changing preferences by a smaller amount. For females on high salaries the response is similar, they maintain a relatively low willingness to commute. In contrast, low income females display a propensity to become more willing to commute longer (no males displayed this behaviour). Again, this result is likely a function of the stereotypical household role of females; low income females who are working are perhaps

more likely to be doing so out of necessity and are prepared to travel to maintain this income particularly if their partner can extract more income from this decision. Understanding that the commute decision has very real household interactions and the costs of decisions may be more likely to be borne by females is an important insight offered to policy makers.

There are major differences between respondents' own preferences and those assigned to them by their partner in the joint choices, indicating that even within a relationship people are poor at synthesising the behaviour of others. In particular, males on higher salaries provide WTAs for their partners which are quite different to those their partner actually expresses. On the other hand, males whose partners work more hours per week provide WTAs which are more the same. Among females, the nature of behaviour while carpooling is surprisingly important in determining if there is a difference in the WTA they provide for their partner versus the WTA their partner expresses. If females state they are the person who drives most when carpooling, or if their partner states that they (the female) is the one who drives most often, then the difference between the WTA value that a female assigns to her partner and the WTA her partner expresses are smaller. One potential explanation is that, stereotypically, males prefer to drive so for partnerships where the female is the primary driver when the household carpools, it is likely that communication over the nature of the commute and who would use the vehicle is potentially more likely to have occurred, thus facilitating a greater understanding of each other's commuting preferences. Again, understanding how intra-household dynamics express themselves in important statistics such as willingness to accept or willingness to pay statistics is crucially important for policy makers to understand how any changes may filter through society.

One result that we want to highlight, given the interest that it generated in discussion with colleagues, is the nature of the correlations that exist between the willingness to commute of individuals and the willingness that they assign their partner. For both males and females these correlations are almost unitary, but remarkably they are in completely opposite directions. Men with high willingness to accept longer commutes incorrectly assign the same willingness to their partner and whereas females with high willingness to commute incorrectly assign low levels willingness. Our intuition for this result is it is explained by societal norms that influence household behaviour; a hypothesis supported by consultation with workplace researchers.

Our regression modelling reveals that males on high salaries have lower willingness to commute, and assign a similarly low willingness to their partner for whom work may not be an economic necessity. It is possible that in this instance the time their partner spends commuting creates disutility because it detracts from an investment of time in other household activities. Men with low incomes are more willing to accept a longer commute for more salary and assign a similar behaviour to their partner. In this instance it is likely that the male is assigning similar willingness because of the need (or desire) for the increased household income offered by travelling more. Alternatively, males could simply be stating that if they are willing to accept a longer commute for increased pay, their partner should have a similarly higher willingness to accept.

While females on low salaries have values similar to males in that that they are prepared to commute further for better pay, unlike males they do not assign this behaviour to their partner. Again, societal norms are most likely at play, in that females on lower salaries may be in more casual or part-time employment and would gladly travel for better working conditions while at the same time not wanting their partner to travel more or be out of the

household more than they currently are. There is some evidence to support this position with respect to the relative salary dummies shown in Table 5. Females on higher salaries are unlikely to want to travel more for work due to persistent (though slowly improving) inequalities of household labour (Liss 2013, Ruppanner and Treas 2014), but may want their partner to travel more to earn more income. The possibility that commuting decisions are influenced by the division of household labour and vice versa is a result that should be first and foremost in the minds of transport policy makers given the potential instability that changes in transport choices can induce within a household. Indeed, future research will seek to investigate this potential link in more detail and also examine the role that household division of labour may play in determining wider travel behaviour.

These results highlight the value of interrogating data such as this; with the extensive regression analysis made possible by the conditional estimates provided via the HB estimation process. As discussed in the methodology, such models have computational as well model specification advantages compared to classical estimation. Specifying interaction terms within utility functions could help to understand why males and females differ, or how differing incomes might change preferences, but three-way interactions are required to isolate the combined effect of income and gender on travel time and cost which adds further computational inefficiency as well as possibly constraining other effects in the model. For example, using interactions to model the willingness to accept of males alone would require 48 additional variables in the utility functions (2 choice attributes by 24 significant socio-demographics). The HB approach is parsimonious and requires very little effort to extend estimation to choice situations with many more attributes. This is different from classical estimation such as Maximum Simulated Loglikehood, where we acknowledge again that, estimation issues aside, the latter can similarly produce posterior estimates at the individual level.

Overall, commuter behaviour is complex but understanding it is immensely important given the myriad ways in which it influences society. The volume and length of commutes have significant implications for urban planning and geo-spatial choices, there are large economic impacts of commuting with respect to labour productivity and the shaping of employment markets and health and quality of life issues are influenced by an individual's commute. Most traffic congestion models assume all individuals make decisions in isolation, but this and other studies have proved this assumption is not valid, specifically arguing that dyads can enjoy a marital premium utility when they are home together which contributes negatively to congestion (de Palma et al. 2015). The richness of the results produced here can assist researchers and policy makers to understand commuting behaviour in far greater detail, albeit in the context of this data; though the modelling methods are easily transferable to different contexts. In terms of implications for future work, the analysis has shown that a rich pattern of behavioural insights in terms of socio-demographic drivers of preferences can be obtained from posterior distributions obtained from a simple HB specification.

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