Transportation economics and the family

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Outline

- Family in transportation & urban economics literature versus models of decision-making within the family
- Why is it important to understand the decision process taking place within family?
- Workplace and Residential location choices within the family
- Departure time and enjoying time with spouse
- Homogamy of preferences: risk aversion
- Mode choice within the family

Family in transportation & urban economics literature versus models of decision-making within the family

Individual versus family decisions

- Until quite recently, only individual models
  - Each spouse independently maximizes his/her own utility
  - Decisions by family members implicitly assumed independent
  - No within-family externality is taken into account
- Recent work on household joint mode choice, car ownership, or residential location
  - Various studies by Hensher and different co-authors
  - Abraham and Hunt (1997): residential and job locations
  - Special issue by Bhat & Pendyala (2005)
  - Special issue by Timmermans and Zhang (2009)
  - Survey by de Palma, Inoa & Picard (2014): discrete choice

Family decisions versus family decision models

- But unitary models (1 decision maker), with no analysis of the bargaining process; in the most elaborate structural models, household utility=weighted average of spouses' travel times, but weights merge preferences (e.g. individual VOT) and Pareto weights
- Collective models:
  - Chiappori, 1988, 1992
- Other bargaining processes:
  - Separate spheres bargaining: Lundberg and Pollak (1993)
  - Stackelberg: Bjorn & Vuong (1984, 1985)
- Objectives here:
  - Analyze the bargaining process taking place within family
  - Disentangle individual preferences / bargaining powers

Collective model setting

- Introduced by Chiappori (1988)
- Generalizes the second welfare theorem
- Assumptions
  - A family entails several decision makers with different preferences, financial and time constraints
  - ➔ No consensus on the best choices
  - Family members may or may not be altruistic
  - Repeated interaction ➔ Full information within family
  - ➔ Strategic but collaborative interaction

Collective model implications

- Pareto optimality: not possible to make one member better-off without making at lease one other worse-off
- Family members behave "as if" they maximize the same weighted utility of family members
- Endogenous Pareto weights, depending on "everything" plus distribution factors
- Two-stage decision process
  - Resources sharing ➔ individual budget sets
  - Each member maximizes subject to own budget set
  - More complex with public goods and other externalities

Income pooling?

- In unitary models,
  - 1 decision maker ➔ maximizes 1 function subject to 1 budget constraint
  - ➔ Income pooling hypothesis: the source of income does not matter
- In collective models, own income increases bargaining power (Pareto weight)
- Change in the beneficent on child allowance in UK, from father to mother ➔ dramatic change in expenses structure
  - Mothers more concerned than fathers by children ➔ the more power they get, the more money goes to children expenses
  - Transferring child allowance to mothers increased their bargaining power and benefitted children at no public cost

Why is it important to understand the decision process taking place within family?

Because spouses do not behave "as if"

- … there was a single decision maker (unitary)
- Two families with identical individual preferences (for each family member) and identical family budget set but different bargaining powers would behave differently
- ➔ collective models improve understanding and predictive power of individual behavior

Because welfare analysis relies on individual preference

- Simple example with 3 couples:
  - $U^H_1=-10*tt^H_1$; $U^H_2=-10*tt^H_2$; $U^H_3=-10*tt^H_3$
  - $U^W_1=-10*tt^W_1$; $U^W_2=-10*tt^W_2$; $U^W_3=-5*tt^W_3$
  - $(p^M_1, p^F_1)=(1,1)$; $(p^M_2, p^F_2)=(1,2)$; $(p^M_3, p^F_3)=(1,2)$
- Couple decisions merges preferences and Pareto weights:

$U^C_1=-10*tt^H_1-10*tt^W_2$; $U^C_2=-10*tt^H_2-20*tt^W_2$; $U^C_3=-10*tt^H_3-10*tt^W_3$

- If facing the **same conditions**, couples 1 and 3 would always make the **same decisions** BUT woman would be **better off** in couple 3 (couple 2 would behave in a different way, more favorable to wife than in couples 1 or 3)
  - ➔ When decisions are jointly made by the family, same behavioral function does not imply same individual welfare!
- If circumstances are such that couples make the **same choices** in the 3 couples (e.g. 1h for each spouse), then spouses are equally well-off in couples 1 and 2, but wife is **better-off** in couple 3
  - ➔ When decisions are jointly made by the family, same individual choices do not imply same individual welfare!

Policy implications

- Welfare analysis and evaluation of projects requires to disentangle preferences from bargaining powers
- Public decision makers may try to influence
  - Opportunities (often at family level)
    - usually costly
  - Preferences
    - difficult and long process
  - Bargaining powers
    - Famous example of UK child allowance reform
    - Under-used although often easy and free
- Some targeted public investment may be offset by redistribution within the family

Applications in transportation

- Residential and job locations
  - Chiappori, de Palma, Picard (2012); + Inoa (2013): residential location: ongoing research
- Departure time
  - De Palma, Lindsey & Picard (2015) EcoTra
- Homogamy of preferences: risk aversion
  - Ongoing research with Dantan & de Palma
- Mode choice (more detailed)
  - Picard, Dantan & de Palma (2013) IJTE
  - Picard, de Palma & Inoa (2015) chapter LUTI
  - Picard, Dantan & de Palma (2015) WP

Workplace and Residential location choices within the family

ONGOING RESEARCH WITH CHIAPPORI, DE PALMA & INOA
COUPLE RESIDENTIAL LOCATION AND SPOUSES WORKPLACES

Context and motivation

- Residential and job location influence wage, rent and commuting time and cost
- Spouses often work in different places but usually share the same dwelling
- ➔ spouses have diverging objectives in residential location
- Couple residential location results both from spouses preferences and from their respective bargaining powers
- Disentangling these 2 components is crucial for understanding, predicting and evaluating residential location
- Each spouse behaves as if s/he maximizes

Short term daily consumption; may compensate imbalances in Long/medium term

Medium term individual commuting costs; depend on travel times

Long term utility of residence; depends on Prices & amenities; Grouped in $V^c(P,Z)$

$$(1-\mu_1)V^m(P,Z) + \mu_1 V^f(P,Z) - (1-\mu_2)c^m(t^m) - \mu_2 c^f\left(t^f\right)$$

$$V^c(P,Z) - (1-\mu_2)c^m(t^m) - \mu_2 c^f\left(t^f\right)$$

$$+ (1-\mu_3)\Psi(a, a) + \mu_3\Psi(a, a)$$

Identification, Convergence and Estimation technique

- MNL on a very large number of alternatives
- Identification strategy
  - μ depends (linearly) on both m and f characteristics
  - $c^g(t^g)$ only depends on g's own characteristics and own commuting time (linear in parameters)
  - Couple's utility non linear in parameters ($\mu * c^g(t^g)$)
    - ➔ concavity problems (ill-behaved likelihood function) ➔ too difficult to converge on a huge dataset ➔ 2-stage minimum distance technique
    - Computation of a χ^2 statistic allowing to:
      - Test specification and Pareto-optimality
      - Recover structural parameters from parameters estimated without imposing structural constraints on parameters

Empirical estimates Using the General Census in Paris Region

- Assuming that μ depends only on spouses' age (in years*10)

Structural P.	Coeff.	Avg (BS)	SD (BS)	t stat	inf	sup
$\mu_m(\%)$	0.78	0.91	0.08	$9.56^{\ddagger}$	0.54	2.56
$\mu_f(\%)$	4.28	4.27	0.08	$53.27^{\ddagger}$	2.85	5.98

  - Consider 2 women; same age for both husbands; woman A 10 years older than woman B ➔ A's Pareto weight 4.28% larger than B's
  - Consider 2 men; same age for both wifes; man A 10 years older than man B ➔ A's Pareto weight 0.78% larger than B's
  - $\mu_f >> \mu_m$ ➔ woman's Pareto weight increases when both spouses age (by 4.28-0.78=3.5% each 10 years)
- Assuming that μ depends only on spouses' nationality (dummy foreign)

Structural P.	Coeff.	Avg (BS)	SD (BS)	t stat	inf	sup
$\mu_1(\%)$	-4.567	-4.695	0.139	$-32.927^{\ddagger}$	-7.482	-2.161
$\mu_2(\%)$	-0.096	0.032	0.269	-0.357	-5.893	4.412

  - Foreign men have less bargaining than French men
  - Woman's nationality does not matter

Disutility of tt when Wife more educated than husband

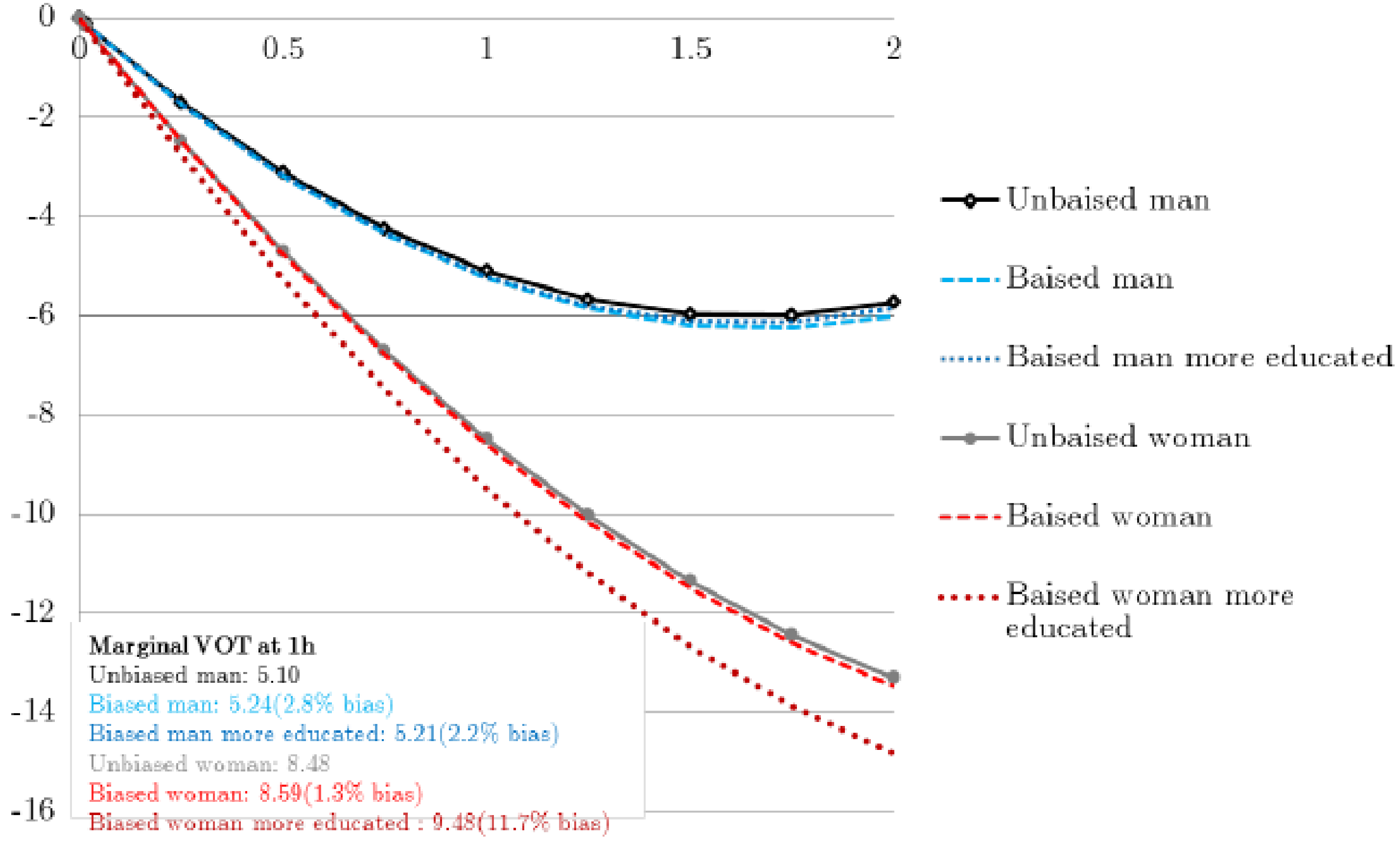


Figure 2. Magnitude of bias in the marginal VOT by education

Policy implications

- A large fraction of the benefits of creating/improving transportation infrastructures is given by the reduction of transportation costs, which heavily depend on individual VOT
- Estimating VOT on RP data using an individual model leads to biased estimates, as documented in the transport literature on family decisions for 30 years
- Estimating VOT from an implicitly unitary family model reduces the bias, but it does not disappear totally
- Necessary to take into account the bargaining process and Pareto weights to fully correct the bias

Departure time and enjoying time with spouse

FROM
DE PALMA A., R. LINDSEY, N. PICARD (2015). TRIP-TIMING DECISIONS AND CONGESTION WITH HOUSEHOLD SCHEDULING PREFERENCES. *ECONOMICS OF TRANSPORTATION*, 4, 1-2, 118-131.

Context and motivation

- Revisiting generalized cost and Vickrey model
- VOT depends on circumstances (marginal utility of time)
  - On road: ν → depends on mode
  - Before departure:
    - alone: ν^I
    - with spouse: ν^M
    - Marital premium: $\Delta = \nu^M - \nu^I$
  - At destination, before t^* : ν^E
  - At destination, after t^* : ν^L
- Correspondence with α,β,γ: tt=Arrival t - Departure t
  - VOT : $\alpha^I = \nu^I - \nu$ alone, $\alpha^M = \nu^M - \nu$ with spouse
  - SDE : $\beta^I = \nu^I - \nu^E$ alone, $\nu^M - \nu^E$ with spouse
  - SDL : $\gamma^I = \nu^L - \nu^I$ alone, $\nu^L - \nu^M$ with spouse

Empirical estimates from SP survey Mimettic

	Husband	Wife
With spouse : $\dfrac{\beta^M}{\alpha^M-\beta^M}=\dfrac{\nu^M-\nu^E}{\nu^E-\nu}$	0.7074	0.5470
Seul : $\dfrac{\beta^I}{\alpha^I-\beta^I}=\dfrac{\nu^I-\nu^E}{\nu^E-\nu}$	0.4741	0.5004
Marital Premium $\dfrac{\beta^M}{\alpha^M-\beta^M}-\dfrac{\beta^I}{\alpha^I-\beta^I}=\dfrac{\nu^M-\nu^E}{\nu^E-\nu}-\dfrac{\nu^I-\nu^E}{\nu^E-\nu}=\dfrac{\nu^M-\nu^I}{\nu^E-\nu}$	0.2333	0.0466
Ratio with spouse : $\dfrac{\beta^M}{\alpha^M}=\dfrac{1}{1+\dfrac{\beta^M}{\alpha^M-\beta^M}}$	0.4143	0.3536
Ratio alone : $\dfrac{\beta^I}{\alpha^I}=\dfrac{1}{1+\dfrac{\beta^I}{\alpha^I-\beta^I}}$	0.3216	0.3335

Implications for traffic equilibrium: Comparison of 3 cases

- Singles or totally selfish spouses: $\nu^M = \nu^I$
- Non-cooperative couples: $\nu^M > \nu^I$; externality imposed by 1st spouse to (man) depart on 2nd ; not internalized
  - Man departs later because he enjoys spending time with his wife but he does not care that she also enjoys spending time with him
  - ➔ increased congestion (and cost) for men
  - Same behavior but increased congestion cost for women
- Cooperative couples: $\nu^M - \nu^I$; externality internalized
  - Man departs later because he cares she enjoys spending time with him
  - ➔ further increased congestion (& cost) for men
  - Behavior and congestion cost same as non cooperative for women
- Effect of cooperation on individual utilities
  - Women all benefit, although unequally
  - Men who depart early better off : Men who depart late worse off
  - All couples receive same joint utility and can be better or worse off

Homogamy of preferences: risk aversion

Ongoing research with de Palma & Dantan

Context and motivation

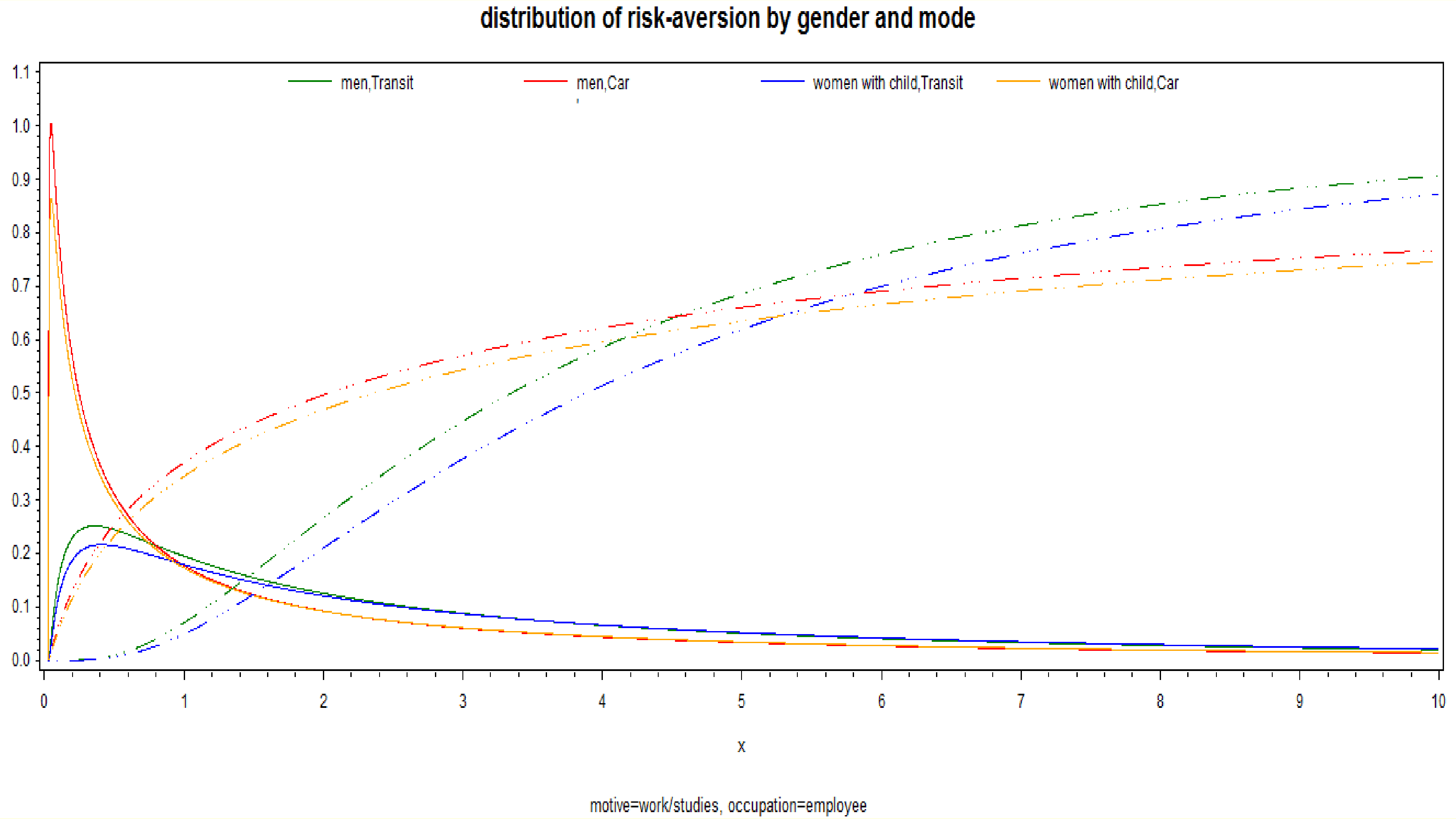
- People do not like variability of travel time
  - Value of reliability (Lam & Small 2003; de Palma, Lindsey & Picard 2005)
  - Mean-Variance totally inconsistent with some distributions of travel time
  - Important to model Utility of a random variable, not directly expected utility
- How to measure risk aversion and what does it depend on?
- What is the "best" utility function? → formal test
- Are spouses' risk aversion levels correlated?

Empirical estimates using SP survey Mimettic

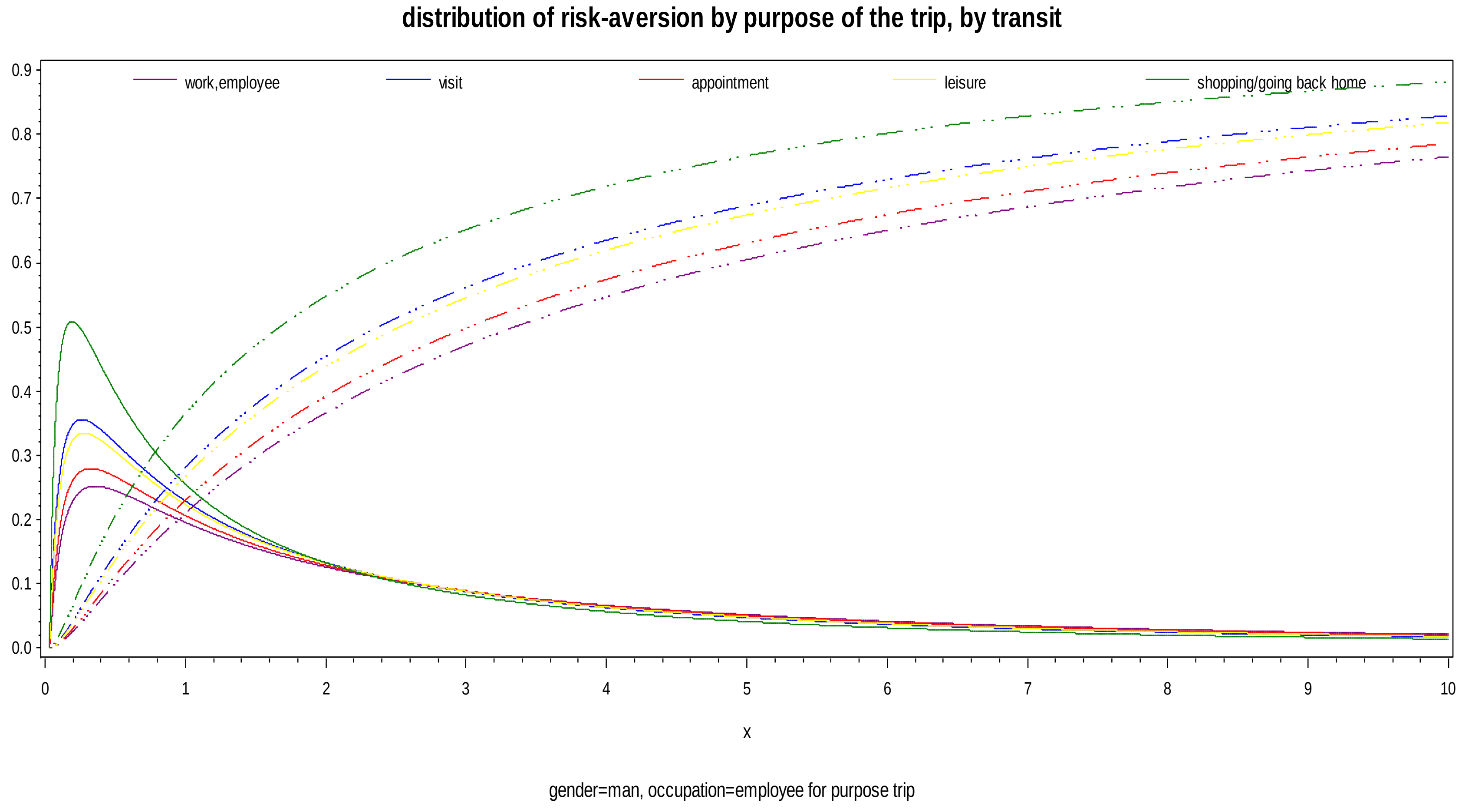
- Scenarii to measure risk aversion
- Trees: 2nd question conditional on answer to 1st question ➔ ordered probit/interval regression techniques
- Combined with panel data techniques to measure a couple effect
- Preliminary results revealed a large proportion of "random" answers

  ➔ Latent variable technique to model the probability to answer randomly as a function of RA threshold corresponding to indifference for this question
- CARA utility clearly rejected in favor of CRRA
- Risk aversion depends on mode, gender, children, purpose of the trip, profession
- Positive assortative mating: 25% correlation

Distribution (density & CDF) of RA by gender and mode, purpose=work, employee



Distribution of RA by trip purpose, man



Policy implications

- Huge cost of variability of travel time in public transport network
- For a given investment amount, the benefit of improving travel time reliability would be by far larger than the benefit of reducing (expected) travel time
- In the Grand Paris Express project (>30 billion € cost), the estimated benefit of improved travel time reliability is about 20%
- Positive assortative mating implies that family can hardly serve as insurance against the variability of travel times

Mode choice within the family

ONGOING RESEARCH WITH DE PALMA & DANTAN

Motivation and context

- Spouses’ mode choices are interdependent:
  - If there is a single car ➔ competition to use it and interdependent choice sets
  - Spouses’ utilities may be different when travelling alone or together, being a driver or a passenger (emotional + financial dimensions)
    - Different generalized VOT :
      - reduced operating cost when ridesharing
      - time spent together seems shorter
    - Different fixed cost (spouse-specific utility of driving/being passenger)
- Joint mode choice is the outcome of a bargaining process
  - Pareto-optimal (collective model) / Stackelberg (who is the leader)?
- Endogeneity of car ownership
  - Bargaining for using a car and/or for buying a car

Data, choice set and information available

- Sample: dual-earner, living & working in IDF: 61,467 couples
- Selected couples: non farmer, commuting only by car or by B
  → 34,915 couples with at least one car, plus 2,082 couples w/o car
- Choice set = joint mode choice (*j(F)*,*j'(M)*) in

{(B,B), (C^A,B), (B,C^A), (C^D,C^P), (C^P,C^D) , (C^A,C^A)}, with

  - B =public transport (Bus)
  - C^A=private Car, driving Alone
  - C^D=private Car, Driver (spouse = Passenger)
  - C^P=private Car, Passenger (spouse = Driver)
- Information available
  - Residential location, each spouse workplace, usual commuting mode of each spouse, number of cars in HH
  - The data do not inform about which alternative is selected in {(C^D,C^P), (C^P,C^D), (C^A,C^A)}, but these alternatives entail different travel times and utilities

What is wrong with independent spouses' decisions?

- Each spouse would maximize his/her own utility independently $U_{iG}^{j} = \alpha_{iG}^{j} - \beta_{iG}^{j}.tt_{iG}^{j} + \varepsilon_{iG}^{j} = V_{iG}^{j} + \varepsilon_{iG}^{j}, \quad G = F, M$
- No competition for car, even when there is only one
- ➔ independent choice sets
- Econometric model: binary logit for choice between
  - Private car (C)
  - Public transport (B)
- Prob. to choose mode j: $P_{iG}(j) = \dfrac{\exp\left(V_{iG}^{j}\right)}{\exp\left(V_{iG}^{jC}\right) + \exp\left(V_{iG}^{B}\right)}, \; j = C, B$

where: V_{iG}^{j} utility provided by mode j to spouse G (=F,M) of couple i

Binary logit results

- Mode choice poorly explained in households with only one car, especially for men
- Probability that both spouses commute by car strongly underestimated when 2 cars, over-estimated when 1 car
- Preferences for modes and VOT would change significantly when a second car is bought
- The ratio of VOT car/transit depends on the number of cars

	Pooled sample		At least 2 cars		Only 1 car	
	Female	Male	Female	Male	Female	Male
Fixed utility of commuting by car						
Intercept (drive)	-1.839***	-0.772***	-0.340***	0.492***	-2.384***	-0.962***
x(workplace in Inner Ring)	2.200***	1.662***	2.243***	1.649***	1.958***	1.485***
x(workplace in Outer Ring)	2.871***	2.270***	2.923***	2.347***	2.573***	1.984***
x(occup="blue collar")	-0.040	0.397***	-0.306*	0.283**	0.166	0.374***
x(occup=employee)	-	-	-	-	-	-
x(occup="professional")	0.509***	0.377***	0.421***	0.208	0.341***	0.278***
x(occup="white collar")	0.467***	0.146**	0.345***	0.133	0.194**	-0.339***
x(occup="self-employed")	2.195***	2.090***	1.948***	1.887***	1.916***	1.770***
xForeign	-0.822***	-0.403***	-1.057***	-0.545***	-0.553***	-0.212***
x# children aged 0-3	0.086***	n.s	0.115*	n.s	0.124***	n.s
x# children aged 4-6	0.131***	n.s	0.210***	n.s	0.092**	n.s
x# children aged 7-11	0.189***	n.s	0.103**	n.s	0.151***	n.s
x# children aged 12-16	0.199***	n.s	0.215***	n.s	0.136***	n.s
Value of time, by mode						
By transit, ref.	1.492***	1.186***	1.421***	1.634***	1.233***	0.749***
By car, ref.	2.446***	1.831***	3.006***	2.734***	2.147***	1.505***
Ratio VOT Car/Transit, Ref.	1.639	1.543	2.116	1.673	1.741	2.009
x(age-40)/10	0.223***	0.007	-0.276***	-0.422***	0.057	-0.060
x(occup="blue collar")	-0.599***	-0.387**	-0.460	-0.851***	-0.603***	-0.075
x(occup=employee)	-	-	-	-	-	-
x(occup="professional")	0.149	-0.152	0.184	-0.361	0.130	-0.002
x(occup="white collar")	0.549***	0.859***	0.760***	0.385	0.264	1.238***
x(occup="self-employed")	-1.096***	-0.468	-1.300***	-0.622	-0.139	-0.047
# observations	34915	34915	18377	18377	16538	16538
Log-likelihood	-16315	-15822	-5595	-5242	-8279	-9192
Pseudo-R² (by gender)	32.6%	34.6%	56.1%	58.9%	27.8%	19.8%
Pseudo-R² (F-M average)	33.6%		57.5%		23.8%	

Joint mode choice by spouses

- The couple jointly chooses mode for both spouses
- The couple maximizes the sum of husband's and wife's utility, weighted by "Pareto weights"

$$U_i^{(j,j')} = \lambda_i . V_{iF}^{j} + (1-\lambda_i) . V_{iM}^{j'} + \varepsilon_i^{(j,j')} = V_i^{(j,j')} + \varepsilon_i^{(j,j')}$$

- Pareto weights depend on respective bargaining powers of spouses and vary across households as a function of individual spouses characteristics (logit formulation to ensure $0<\lambda<1$)
- Competition for the unique car plays a significant role in reducing the choice set (each spouse cannot commute alone by car when there is only 1 car in the HH)

Results of joint MNL more consistent

- Spouses' preferences less dependent on the number of cars

	Only 1 car	At least 2 cars	Pooled
Ratio VOT Car/Transit for woman	*1.925*	*2.231*	*1.900*
Ratio VOT Car/Transit for man	*1.773*	*1.717*	*1.6120*

- Wife's Pareto weight is larger:
  - for owners than for tenants
  - when the man has a temporary job contract
- But…the average VOT of spouses is several times larger when the woman drops the man than when the man drops the woman:
  - Very conservative view of gender roles
  - Either women dislike driving or men dislike being driven
- 2 strategies to solve inconsistency:
  - Consider endogenous car ownership
  - Consider another bargaining process: a Stackelberg game

Endogenous car ownership: nested model

- Decision to buy a 2nd car:

$$U_i^{2Car} - U_i^{1Car} = \underbrace{\lambda_i . V_{iF}^{2Car} + (1-\lambda_i).V_{iM}^{2Car} + \mu^{2Car} I_i^{2Car}}_{V_i^{2Car}} + \varepsilon_i^{2Car} - \underbrace{\mu^{1Car} I_i^{1Car}}_{V_i^{1Car}} - \varepsilon_i^{1Car}$$

- Decision to buy the 1st car:

$$U_i^{Car} - U_i^{NoCar} = \underbrace{\lambda_i . V_{iF}^{Car} + (1-\lambda_i).V_{iM}^{Car} + \mu^{Car} I_i^{Car}}_{V_i^{Car}} + \varepsilon_i^{Car} - \underbrace{\mu^{NoCar} I_i^{NoCar}}_{V_i^{NoCar}} - \varepsilon_i^{NoCar}$$

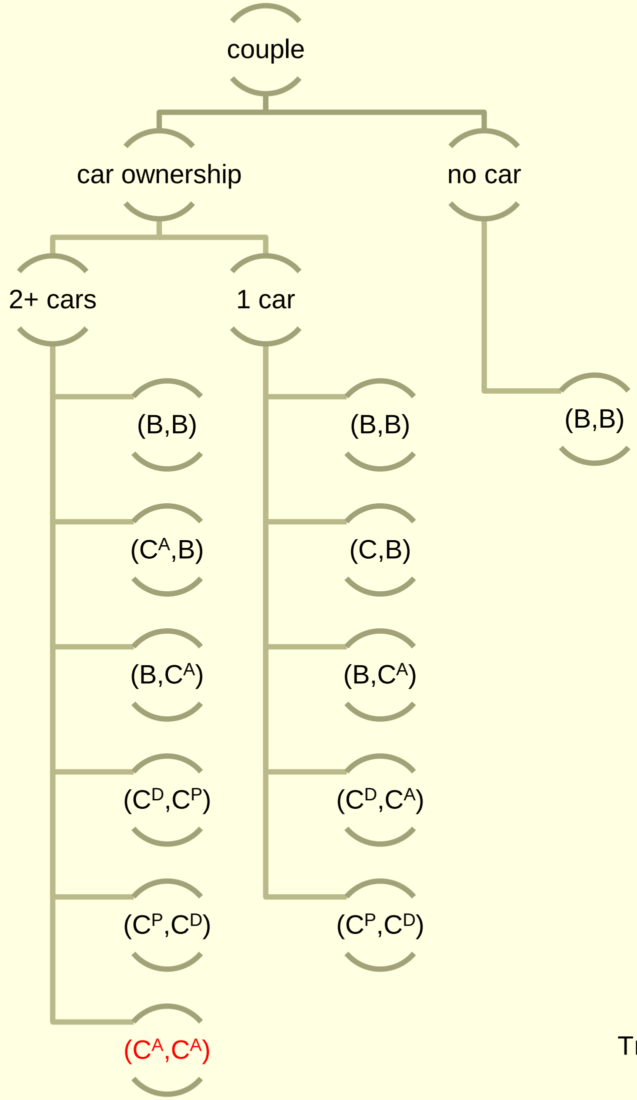
$V_{iG}^{k\,Car}$: Fixed utility of *k* car(s) , *k=0, 1, 2*

➔depends on age, number of children, district of residence (parking)

$I_i^{k\,Car}$: Value of the alternatives available if *k* cars

- Computed from mode choice (lower part of the tree)

3-level Nested model & results



- The average VOT of spouses is slightly lower when the woman drops the man than reverse

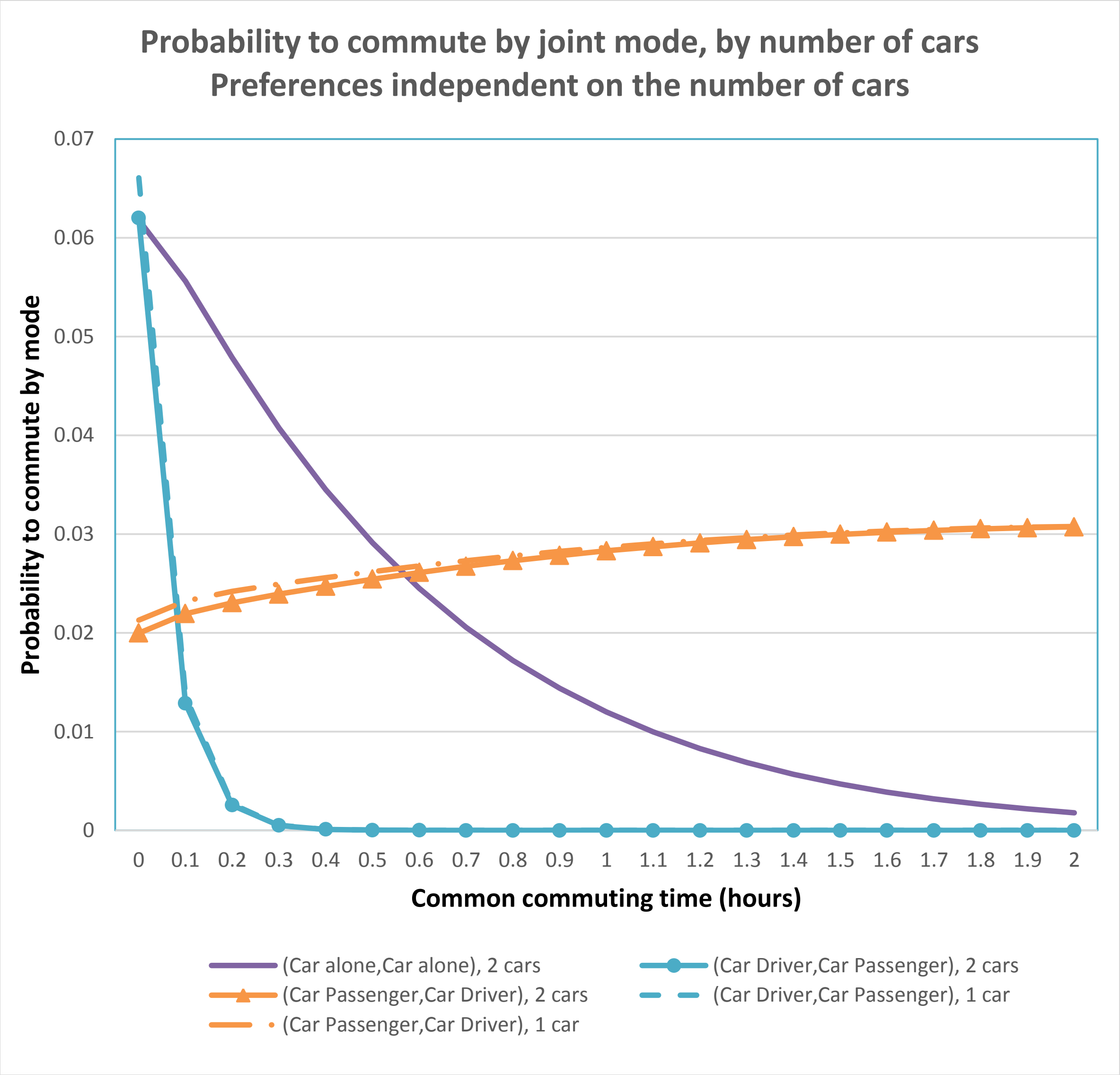
⇒ The preferences and Pareto weights are significantly biased by the endogeneity of car ownership when car ownership is assumed exogenous in the collective model

- Bargaining power significantly affects not only car use but also car ownership

	Pooled
Ratio VOT Car/Transit for woman	*1.900*
Ratio VOT Car/Transit for man	*1.913*

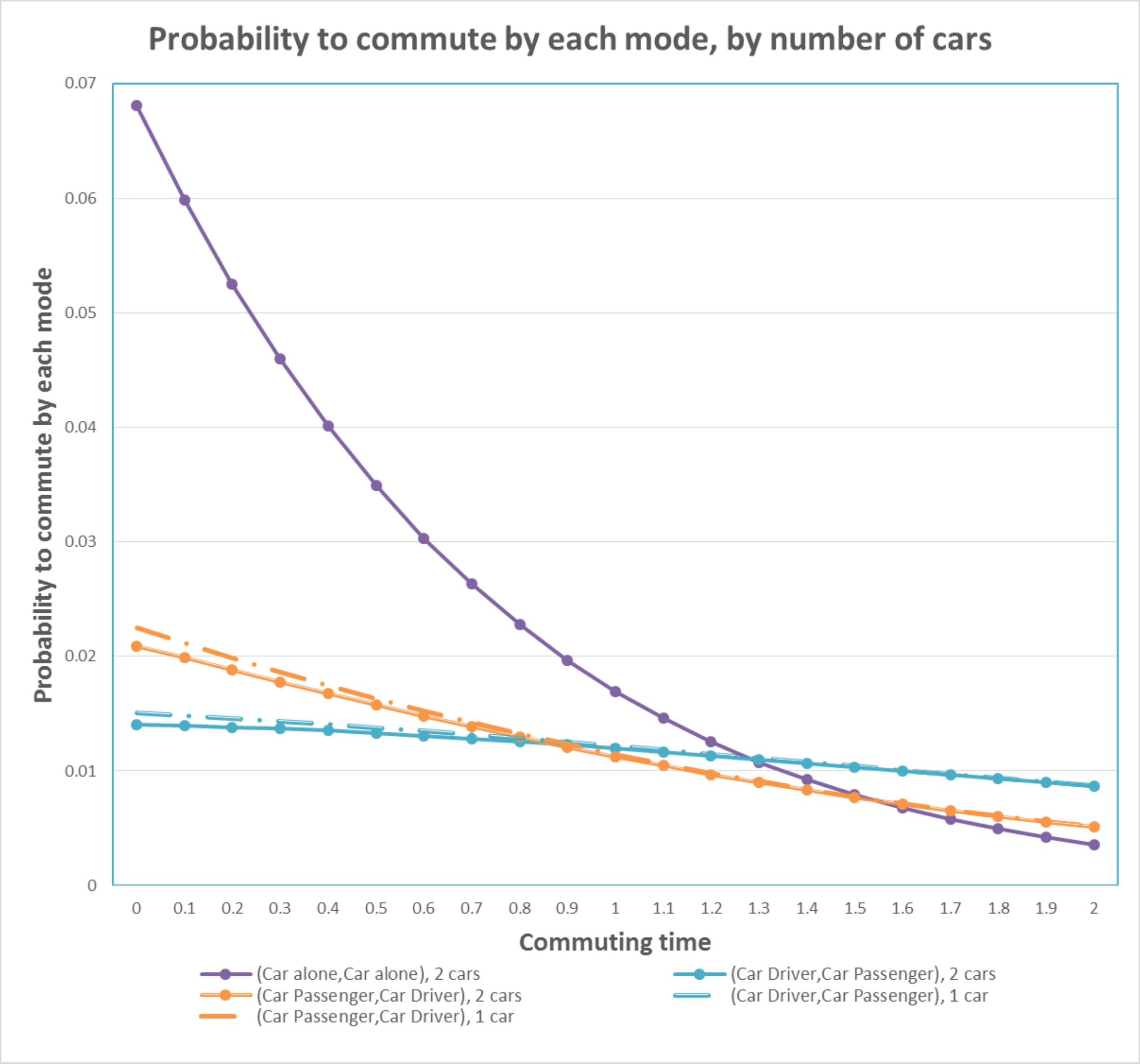
Probability to commute by car, MNL

- Proba to commute together increases with tt
- With 2 cars, proba that each spouse drives alone decreases
- Proba to commute together and woman is the driver is close to 0 when tt>20 min



Probability to commute by car, NL

- Proba that both spouses commute by car decreases with travel time
- With 2 cars, proba to commute together lower than proba to drive alone …when tt <1h20
- When commuting together, proba that woman drives is :
  - slightly lower for short trips
  - slightly larger for longer trips



Stackelberg model

1. Leader determines her 1st-best mode j_1 and the resulting follower's choice set $C(j_1)$ and preferred mode i_1 in $C(j_1)$

⇒ i_1 and j_1 are consistent, the leader announces i_1 and the follower chooses j_1; otherwise:

2. Leader determines her 2nd-best mode j_2 and the resulting follower's choice set $C(j_2)$ and preferred mode i_2 in $C(j_2)$

⇒ i_2 and j_2 are consistent, the leader announces i_2 and the follower chooses j_2; otherwise:

3. Leader determines her 3rd-best mode j_3 and the resulting follower's choice set $C(j_3)$ and preferred mode i_3 in $C(j_3)$

⇒ the leader announces i_3 and the follower chooses j_3

2 car-hh

Choice probabilities :

$P^2(B,B)$

$P^2(B,C^A)$

$P^2(C^A, C^A)$

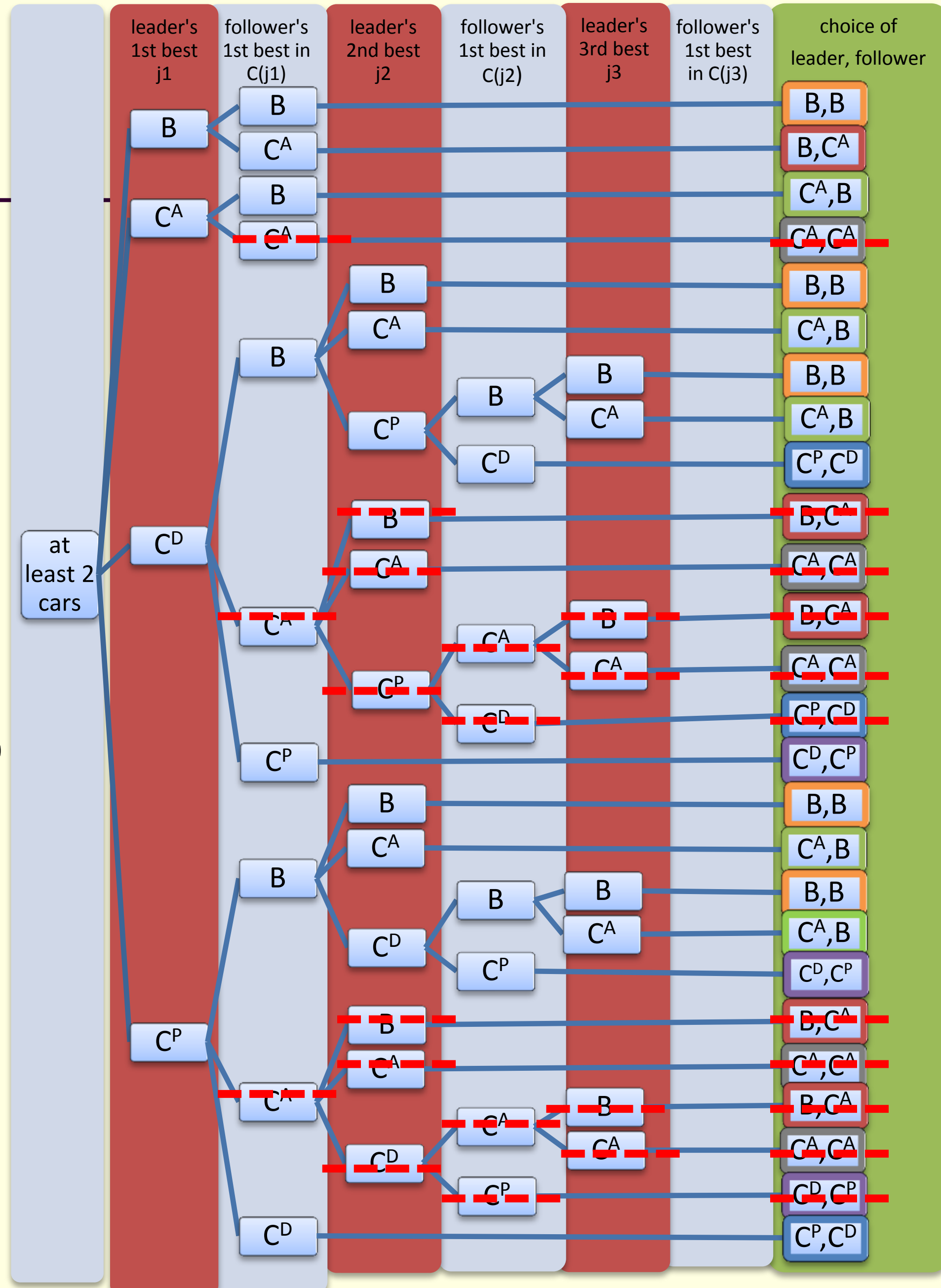
$P^2(C^A,B)$

$P^2(C^P, C^D)+P^2(C^D, C^P)$

do not depend on who is leader

1 car-hh

The choice probability $P^1(B,B)$ does not depend on the leader but the other probabilities $P^1(i,j)$ do



With 2 cars, the only conflict is when the 1st best is Driver and 2nd best is Passenger for both spouses (or 1st=Passenger & 2nd=Driver). In these cases, the leader imposes his/her first best . => Who drives depends on the leader but not observed in our data.

Stackelberg results, exogenous car ownership

- Both spouses prefer the driving seat
- Men particularly dislike being the passenger
- Women’s VOT lower when driving the man than when driving alone
- Determinants of leadership similar to determinants of Pareto weight in collective model

Endogenous car ownership in Stackelberg model

- Conditional on # cars, the leader determines the follower's choice set➔power to exclude alternatives
- Conditional on # cars and leader's proposal, the follower has the final word➔power to select the best alternative in a reduced set
- Implications: leader has incentives to buy the 1st car; follower has incentives to buy the 2nd car
- Nested model
  - Leader chooses to buy a (1st) car or not
  - Follower chooses to buy a 2nd car or not
  - Leader proposes car use as explained in the exogenous car ownership case
  - Followers reacts as explained in the exogenous car ownership case

Conclusions

- Family really matters for transportation choices
- Taking into account individual characteristics and attributes is not sufficient to analyze family decisions

The family decision process also matters

- Ongoing research
- Still a lot to do
- Hope we will have a lot of followers