Bargaining for the Last Mile and Environmental Preferences of Stakeholders

A Laboratory Economic Experiment

Laurent Denant-Boemont, Javier Faulin, Sabrina Hammiche & Adrian Serrano

Univ Rennes & CREM CNRS, Public University of Navarra

AFET Inaugural Conference, 2023, nov., Paris

1. Introduction (1)

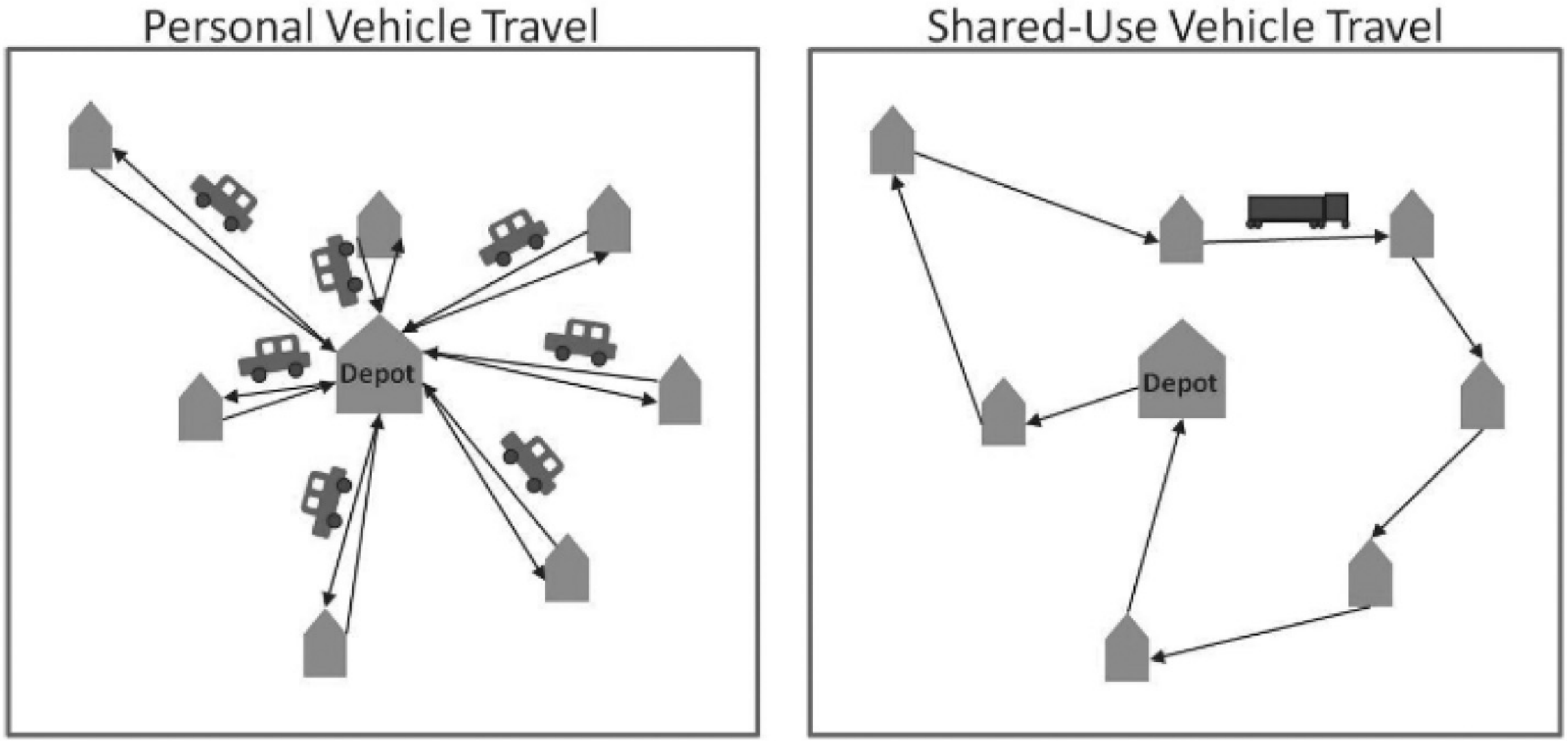
- Explosion of e-commerce,
  - Is it an opportunity or a trap regarding environmental impacts of goods distribution?
- A hot topic: The Last Mile Cost (LMC), i.e., the cost of delivery related to the distance between the final retailing distribution point to the final destination, mostly consumers' living places (Goodman 2005),
  - Empirical Studies (Sarder 2020): LMC could represent 30% of transportation costs, and 45% of supply-chain costs.

- *This research is a part of the Projet TransAnalytics project (Work Package 1 : Sustainability issues and challenges in freight transport and mobility activities in smart cities) supported by the Spanish Ministry of Science & Innovation*.

1. Introduction (2)

- Environmental costs of the Last Mile amount to 32% of CO2 emissions for e-commerce (Weber et al 2009, US), or 47% of carbon footprint (Van Loon et al 2015, Melacini & Tapia 2018)
- However, due to substitution between physical shopping and e-commerce, as e-commerce develops, it has a potential to decrease the negative impacts of shopping on the environment.
  - *Indeed, as delivery trucks optimize their routes, it is more sustainable than shopping trips to stores where customers use personal cars.*
    - Siikarvirta et al 2003 estimate in an empirical study that e-commerce could lead to a potential decrease of 54% to 93% in the distances traveled, leading to a reduction from 18% to 84% of GHG emissions from logistics.
  - See the LR of Buldeo Rai 2021: In-store purchases vs online purchases
    - Most studies are favorable to e-commerce about environmental impacts.
  - E.g., Mommens et al 2021: Study Case for Belgium
    - Sustainability Impact: Home Deliveries are prefered to collection points in rural and urbanised areas, whereas the reverse is true for urban areas

Wygonik & Goodchild 2012

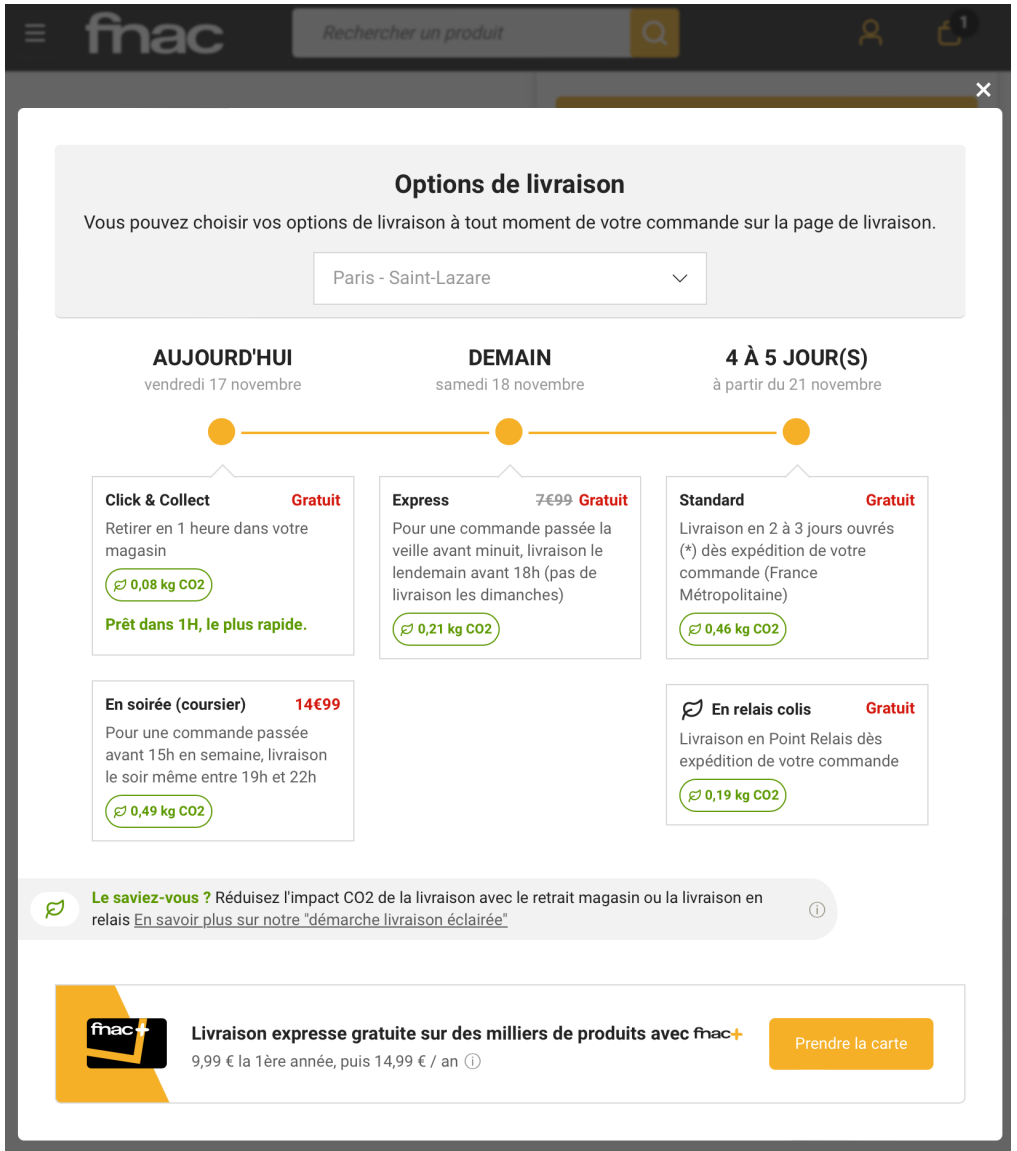


1. Introduction (3)

- Mostly, empirical studies focus on the supply side, ie., LSP (Logistics Service Providers) and e-tailers,
- Consumers are also important (Sallnäs and Bjorklund 2020) but are reluctant to pay for delivery (Buldeo Rai et al. 2019; Nguyen et al. 2019), which deter suppliers from using financial incentives for delivery policies,
  - Non-financial incentives: Buldeo Rai et al (2021) show with an online hypothetical experiment that information about sustainability of delivery increases the share of sustainable delivery choices by customers.

The Chart for Committing to Reduce Environmental Impact of E-Commerce (2021)

https://www.ecologie.gouv.fr/sites/default/files/21120_charteCommerceLigne_2023-07.pdf



Introduction (4): Our Paper

- Questions
  - How environmental preferences of stakeholders could influence delivery policies for the sellers and delivery choices for the consumers?
  - How salient messages about environmental impacts of delivery choices influence behaviors?
- Method
  - Designing a new situation game where stakeholders bargain between delivery options and are confronted to private and external costs of delivery
  - Build a laboratory experiment to test the situation game and how outcomes could be influenced by environmental messages
- Results:
  - Message matters: Buyers are willing to pay to choose delivery that minimizes environmental costs,
  - Trade Agreement on DH is increasing thanks to the messages
  - The effects of messages on prices' proposals for the sellers remain unclear.

Introduction (5): Why a Laboratory Economic Experiment?

- Revealed Preferences methods relying on actual choices in the field: For properly estimating the economic impact of any policy on actual choices, need to estimate operating costs for the sellers, willingness to pay of the buyers,…
- Stated Preferences Methods: Hypothetical Bias
- LEE is a revealed preference method (Harrison 2006): Choices with Real Consequences (especially monetary ones)
- Induced Value Setting (Costs and Benefits are pre-specified), which helps to:
    1. Focus on bargaining process,
    2. Observe the impact of a salient message on this bargaining process.

2. Theoretical Background

- UBG with Minimum Acceptable Offer (Guth and Kocher 2014 ; Rodriguez Lara 2016, Han et al 2017): Simultaneous Game.
- *Bargaining between 2 players, a seller and a consumer* about the price for Delivery at Home (DH) ; Click-and-Collect (CC) is the outside option ;
  - If DH, private transport cost for the seller ; If CC, private transport cost for the consumer ;
- *Public Bad*: Delivery Policy chosen by partners implies Shared External Costs for Pollution and Climate Change.

2. Theoretical Background

SELLER

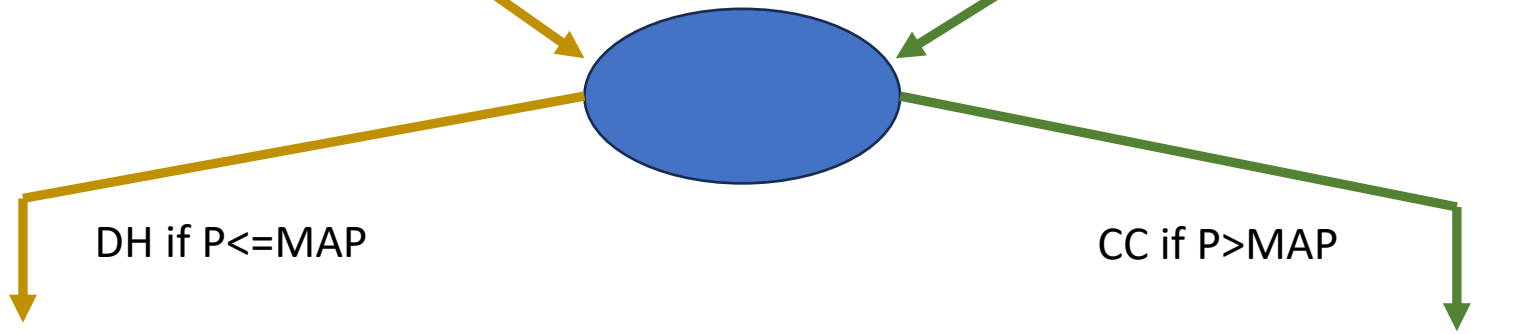
BUYER

Assumptions:

1) $MPTC_s < MPTC_b$
2) $METC_s < METC_b$

P: Price for Home Delivery (DH)

MAP: Maximum Acceptable Price (for DH)



DH if P<=MAP

CC if P>MAP

$$S_s^{DH} = WTS + p - MPTC_s - \frac{METC_s}{2}$$

$$S_b^{DH} = WTP - p - \frac{METC_s}{2}$$

$$S_s^{CC} = WTS - \frac{METC_b}{2}$$

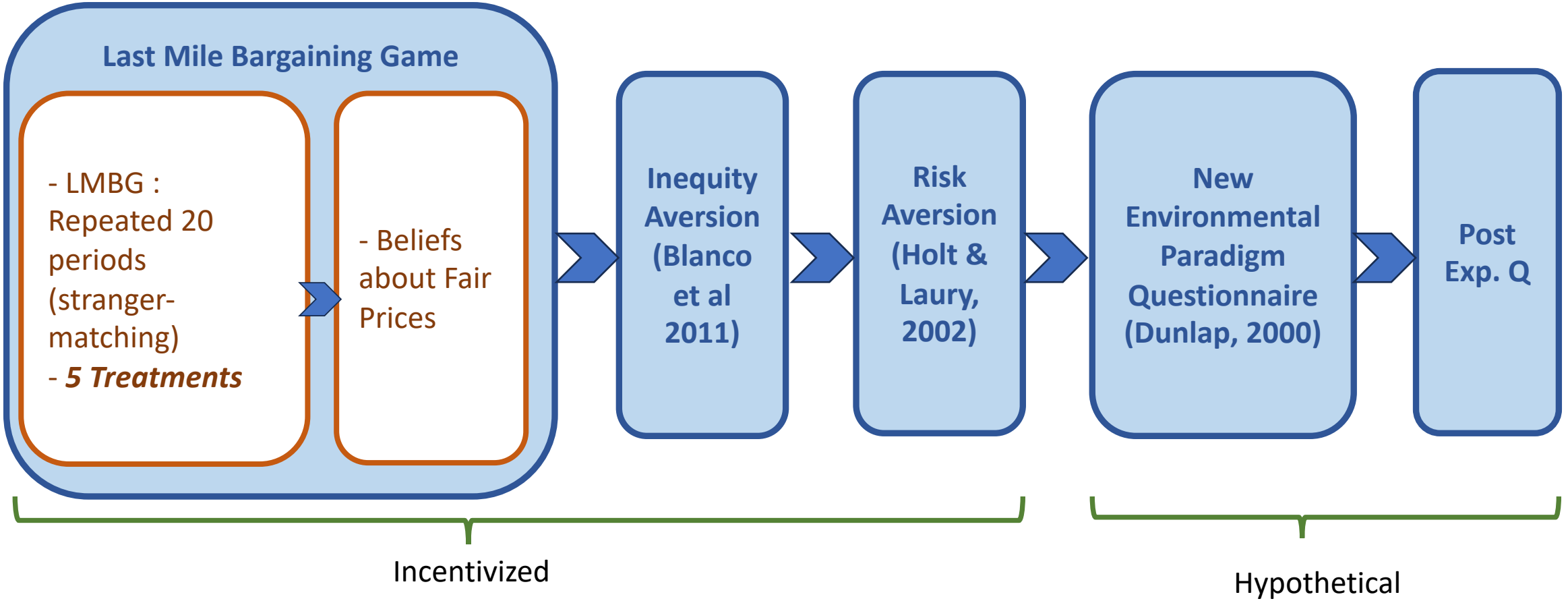
$$S_b^{CC} = WTP - MPTC_b - \frac{METC_b}{2}$$

Nash Equilibrium occurs when $p^* = MPTC_b + \frac{METC_b}{2} - \frac{METC_s}{2} - \varepsilon$

3. Experimental Design: The Sequence

- Between-Subject Design,

- For each participant, the sequence is:



3. Experimental Design: Treatments

- The environmental message is:
  - ***"According to expert studies published on the European Commission's website (European Commission 2020 Handbook on the External Costs of Transport), the cost of air pollution and climate change per ton per kilometer travelled is (at least) 3 times higher when this ton is transported by a private individual in his or her own vehicle than when this ton is transported by a professional carrier (whether in a commercial vehicle or in a heavy goods vehicle)"*** *(translated from French)* (EC 2019, Handbook of External Costs for Transport)
- Based on a calibration study about the external unitary costs per ton-kilometer (European Commission, 2020)
- Our calibration of METC is consistent with that!

3. Experimental Design: Numerical Calibration of the Experiment

	Seller (1)	Buyer (2)
WTS or WTP (endowment)	100	100
Private transport cost	20	40
External transport cost for pollution and climate change	10	30

x_i with $i = (1; 2)$

$MPTC_i = \gamma x_i$

$METC_i = \gamma x_i(1 - k^{x_i})$

with
$\gamma = 20, k = 0.5$

Players' Payoffs in different delivery scenarios

Situation	Final payoff for the seller	Final payoff for the buyer	Economic Efficiency	Ratio Ps/Pb
No agreement reached CC)	100 – (30/2) = 85	100 – 40 – (30/2) = 45	130	1.9
DH: Agreement with p = 49 (100% of surplus for seller)	**100 + 49 – 20 – (10/2) = 124**	**100 – 49 – (10/2) = 46**	**170**	**2.7**
DH: Agreement with p = 30 (equal share of DH surplus)	100 + 30 – 20 – (10/2) = 105	100 – 30 – (10/2) = 65	170	1.6
DH: Agreement with p = 10 (0% of surplus for seller)	100 + 10 – 20 – (10/2) = 85	100 – 10 – (10/2) = 85	170	1

Inequity Aversion model

- Given the potential inequity in final payoffs between the seller and the buyer, we elicitate at the individual level the parameters of Fehr & Schmidt 1999's inequity aversion model by using the method by Blanco et al 2011:

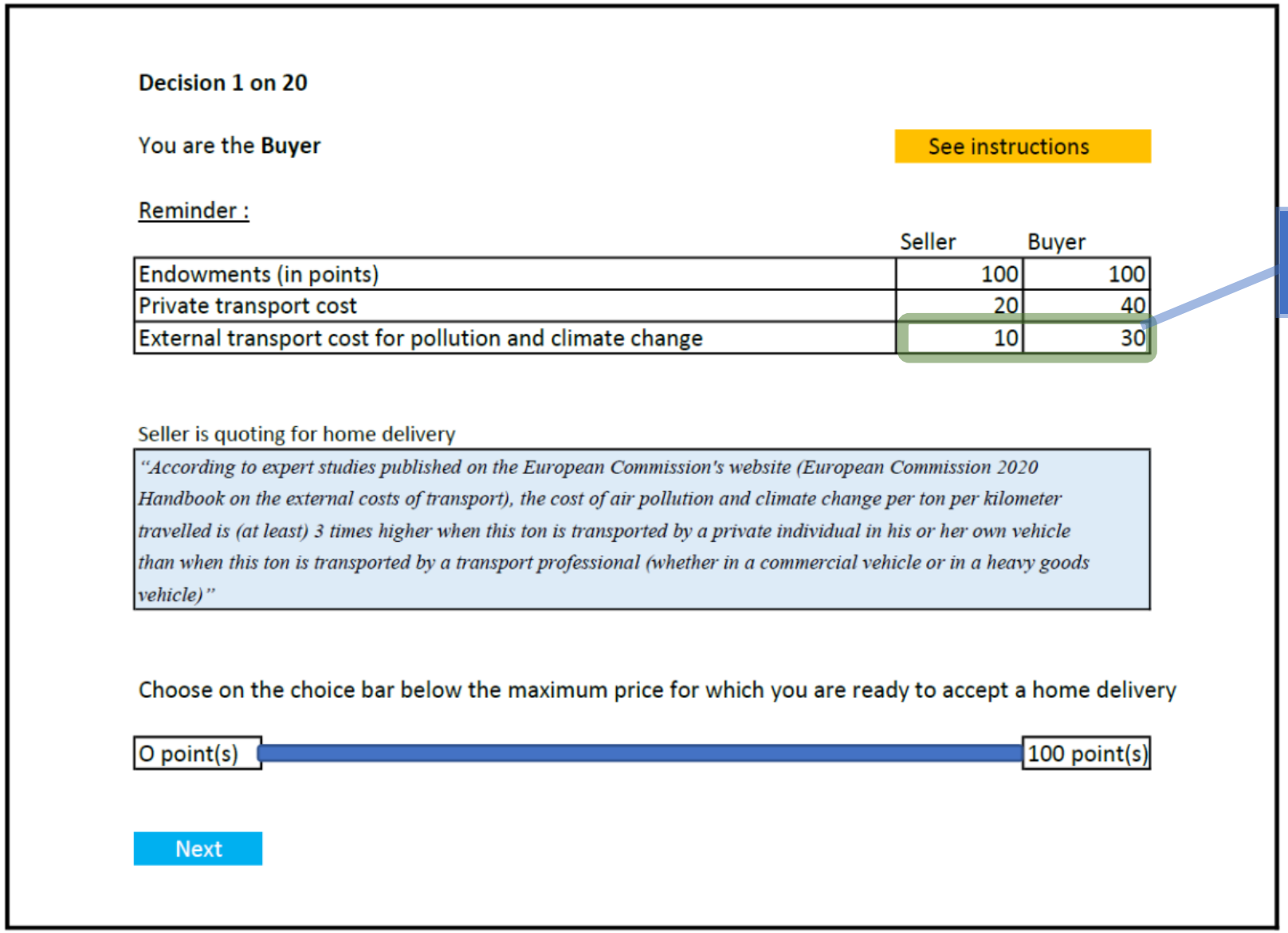
$$U_i(x_i, x_j) = x_i - \alpha_i(x_j - x_i), \qquad if\ x_i \leq x_j$$

$$= x_i - \beta_i(x_i - x_j), \qquad if\ x_i > x_j$$

3. Experimental Design: Treatments and Structure

- 5 treatments:
  1. **Benchmark: No Message,**
  2. **Message for the Buyer**,
  3. **Message for the Seller,**
  4. **Message for both partners**
  5. (Neutral Benchmark)
- Each session : 2 groups,
- Group level: Stranger-Matching Design (roles remain constant, but a seller is matched randomly with a buyer belonging to his group at each period)
  - An important point: *If message for a participant, the partner is not aware of it!* (in order to rule opportunistic motive for increasing prices for sellers or peer pressure for buyers to increase WTP)

Screen's choice for the buyer (treatment 2 or 4)



Decision 1 on 20

You are the **Buyer**

See instructions

Reminder :

	Seller	Buyer
Endowments (in points)	100	100
Private transport cost	20	40
External transport cost for pollution and climate change	10	30

Seller is quoting for home delivery

"According to expert studies published on the European Commission's website (European Commission 2020 Handbook on the external costs of transport), the cost of air pollution and climate change per ton per kilometer travelled is (at least) 3 times higher when this ton is transported by a private individual in his or her own vehicle than when this ton is transported by a transport professional (whether in a commercial vehicle or in a heavy goods vehicle)"

Choose on the choice bar below the maximum price for which you are ready to accept a home delivery

O point(s) — 100 point(s)

Next

Consistent with the message

Behavioral Conjectures

- Assume a positive spread between proposals (Pb > Ps), ensuring DH contract,
  - The higher the spread, the greater acceptance rate
- Efficiency Concern: *What is the social outcome that maximizes economic surplus (and also minimizes environmental costs)?*
- Fairness Concern: *What is the social outcome that maximizes surplus and who should be rewarded for reaching it?*
- If transport is optmized by DH:
  - For the seller, increase of her price proposal;
  - For the buyer, increase of his maximum price.

Behavioral Conjectures for Treatment Effects

Benchmark

Message for the buyer : **Δ Pb > 0**

Message for the Seller

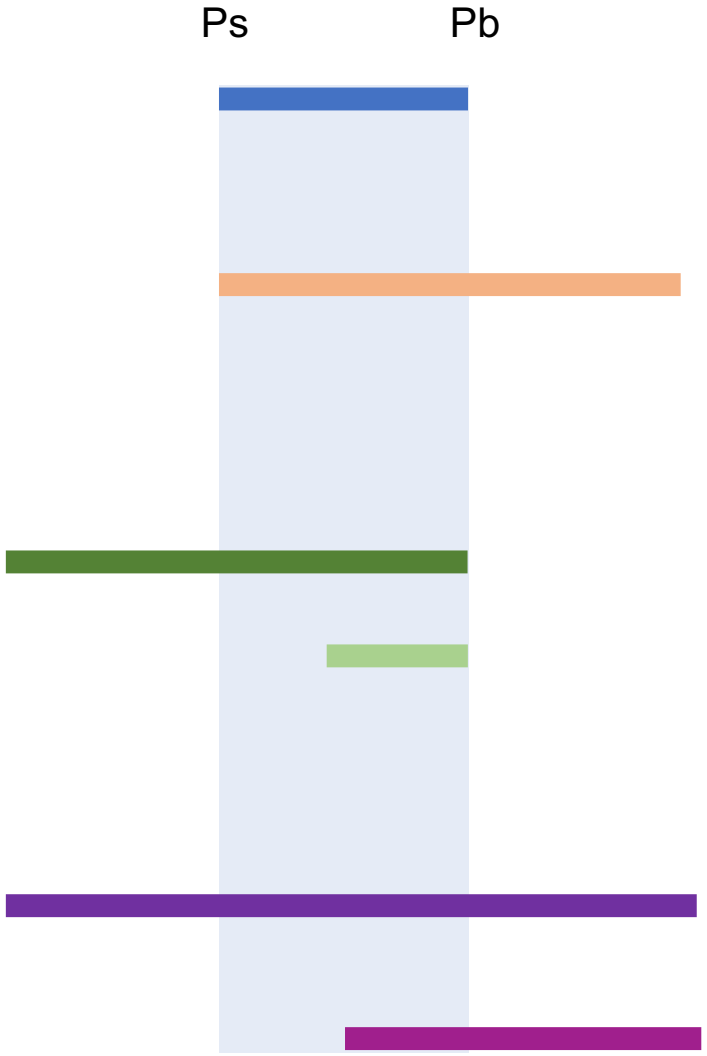
A) Efficiency Concern: **Δ Ps < 0**

B) Fairness Concern: **Δ Ps > 0**

Message for Both

A) Efficiency Concern for the seller

B) Fairness Concern for the seller



4.Experimental Results: Overview of Data

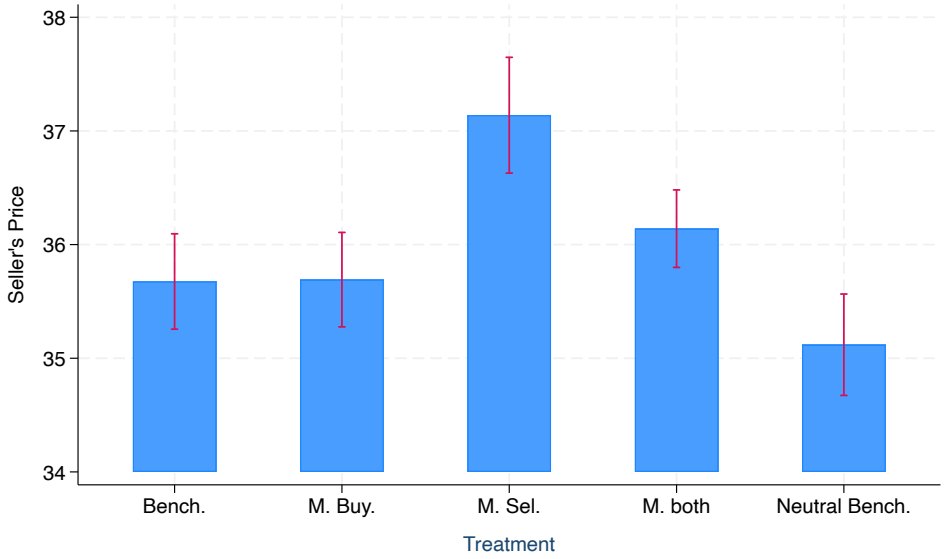
- From September, 2022 to June, 2023: 20 sessions in LABEX EM, Rennes, France
  - Average duration is 1h30', average payoff is 28€

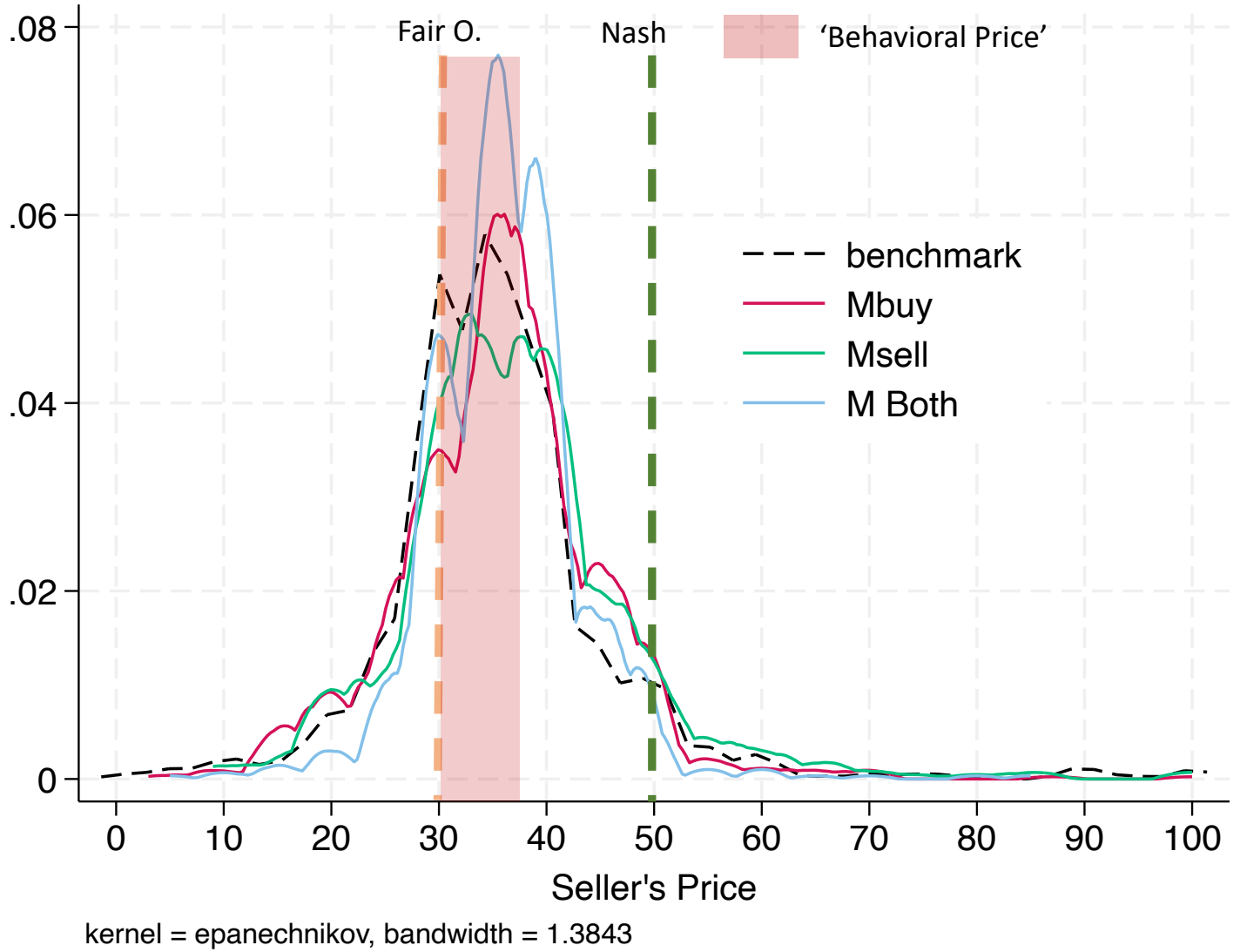
Treatment	N. participants	N. indep. Obs.	Total n. of obs.
Benchmark	130	11	2600
Message to the Buyer	96	8	1920
Message to the Seller	86	8	1720
Message for Both	82	8	1640
(Neutral Benchmark)	42	4	840
Total	436	39	8720

Descriptive Statistics of the Participants Sample

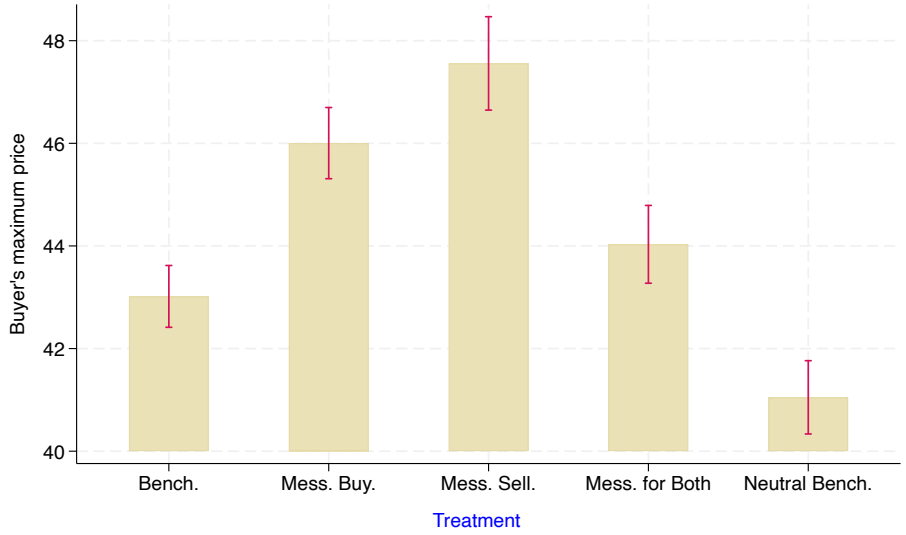
variable	Basic stats.: Mean (s.d., if relevant)
Age	20.5 (4.64)
Female participants	50%
Business & Economics Students	8%
Alpha (disadvantageous inequity aversion parameter)	1.14 (1.6)
Beta (advantageous inequity aversion parameter)	0.61 (0.19)
Risk Preference	34.17% RN/RL, 65.83% RA, switch: 6.02 (1.84)
NEP Score	2.18 (0.44), Cronbach's Alpha=0.704
Fair Price Belief	Seller: 36.55 (11.62) Buyer: 39.75 (15.93)
Fair Price Belief for Partner	Seller: 36.79 (10.73) Buyer: 37.43 (5.54)

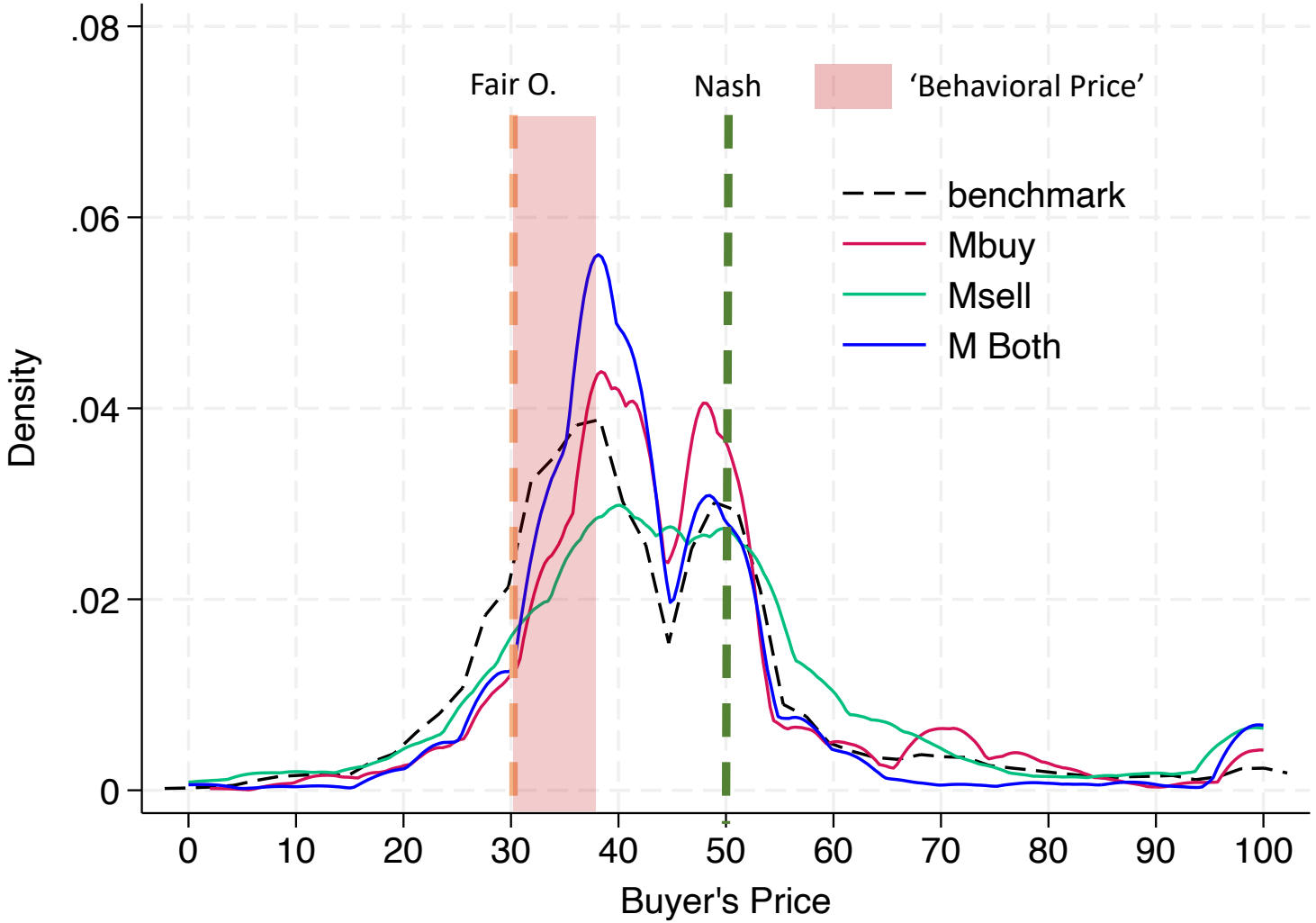
4. Experimental Results: Seller's Price





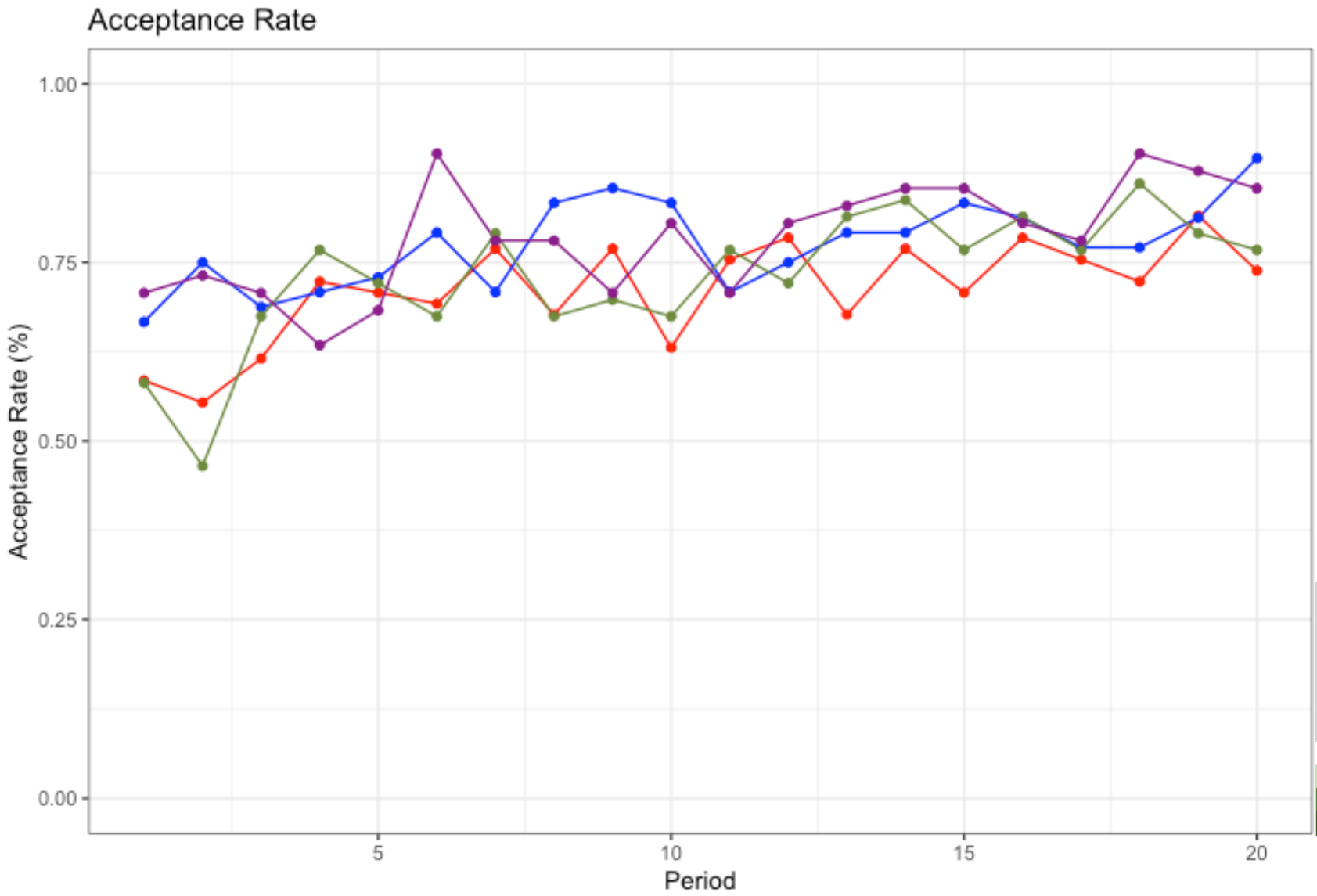
4. Experimental Results: Buyer's Maximal Price (Maximum Acceptable Price)





kernel = epanechnikov, bandwidth = 2.2149

4. Experimental Results: Acceptance Rate



Treatment

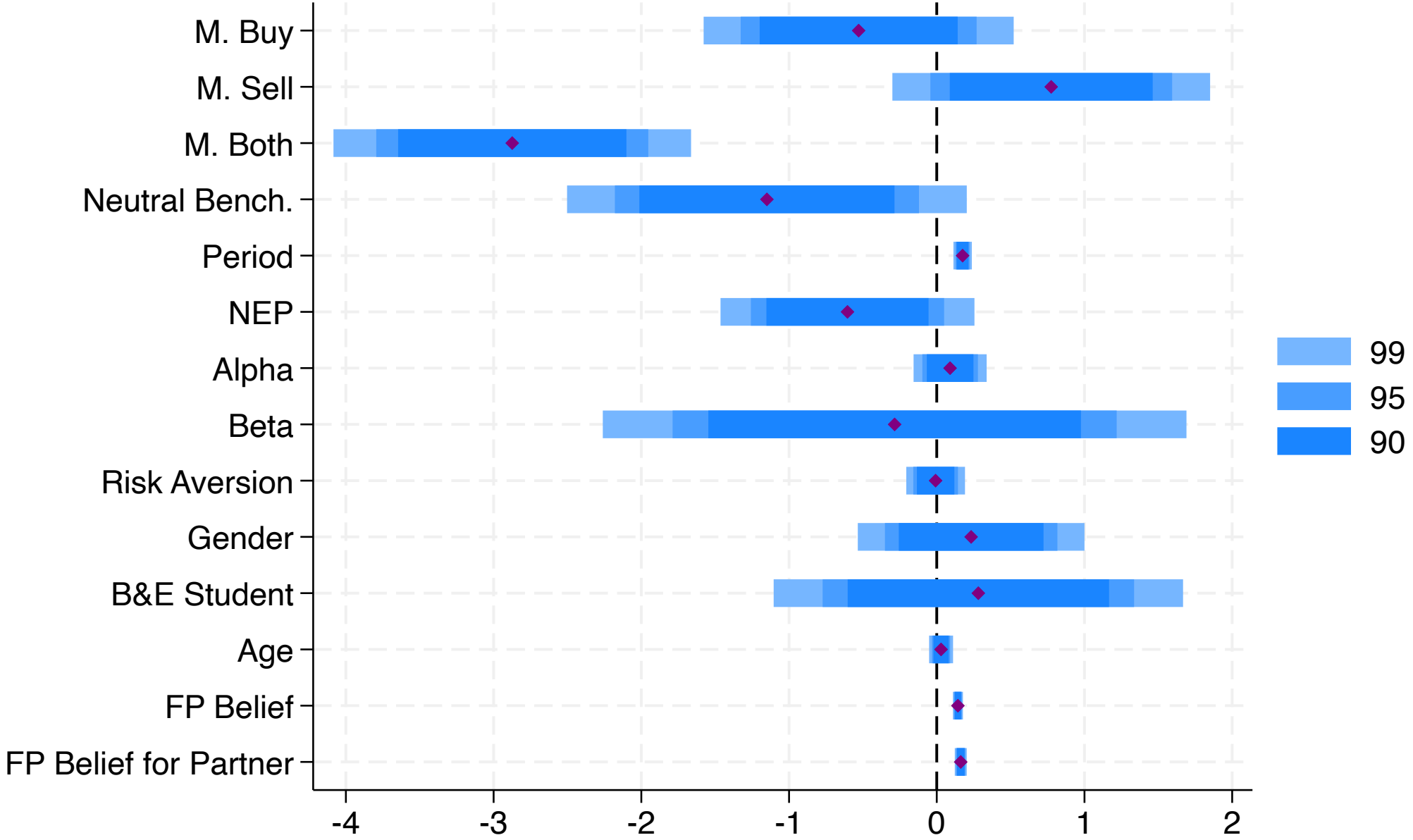
1 - Benchmark	: 71.2%
2	: 77.5%
3	: 73.1%
4	: 78.5%

Mann-Whitney W Ranksum Test:

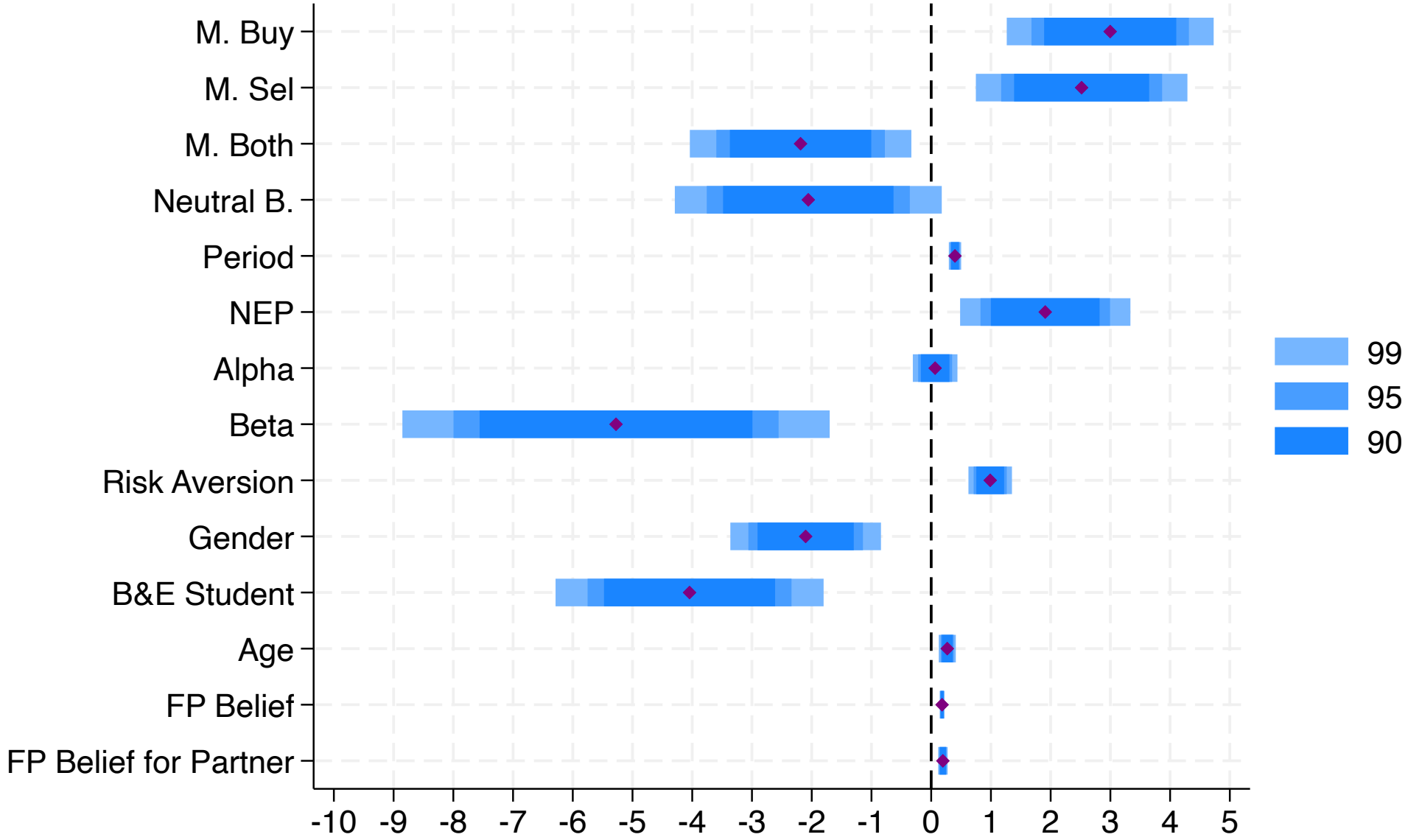
	1	2	3	4	5
1					
2					
3					
4					
5					

	10%
	5%
	1%

4. Experimental Results: OLS on Seller's price



4. Experimental Results: OLS on Buyer's Maximum Price



5. Concluding comments

- Our experimental design enables us to explore how interactions in the supply chain between e-tailers and customers might affect sustainability of delivery policies.
- The results indicate that the environmental costs of last mile delivery are a great concern for customers, who are ready to accept quite high delivery prices to decrease it.
  - *Providing information about these environmental costs to buyers further increases their acceptance of high prices for delivery.*
- For sellers, the effects are lighter & more ambiguous,
  - However, (weak) empirical evidence for decrease in prices' proposals, that may be related (?) to some efficiency concern for the seller.
- *The messages delivered increased significantly trade agreement between stakeholders*.
- Our findings suggest that non-financial incentives may impact the sustainability of delivery choices by the consumers in the e-commerce.