Disentangling status quo bias and zero-price effect for more robust estimation of welfare changes

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Presentation outline

- Issues occur when there is zero-cost in SQ alternative
- Study objectives and survey design
- Simulation results
- Stated choice pilot survey results
- Conclusions

Issues related to zero-cost status quo alternatives

Status quo bias recap I

- Respondents disproportionately choose the status quo alternatives
- Estimated by the status quo constants
  - Might lead to Inflated cost sensitivities and downward bias in WTP if not included (Adamowicz et al, 1998; Boxall et al, 2009 etc.)
- In particular for WTP measures, analysts should aim to reduce the role of the constants as much as possible (Hess et al., 2011)

Dan Ariely's chocolate experiment

$0.01

27%

$0.15

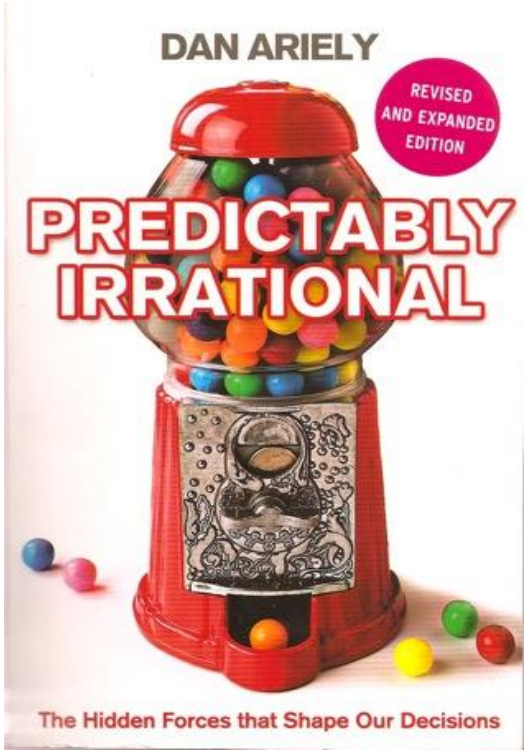
73%

Free

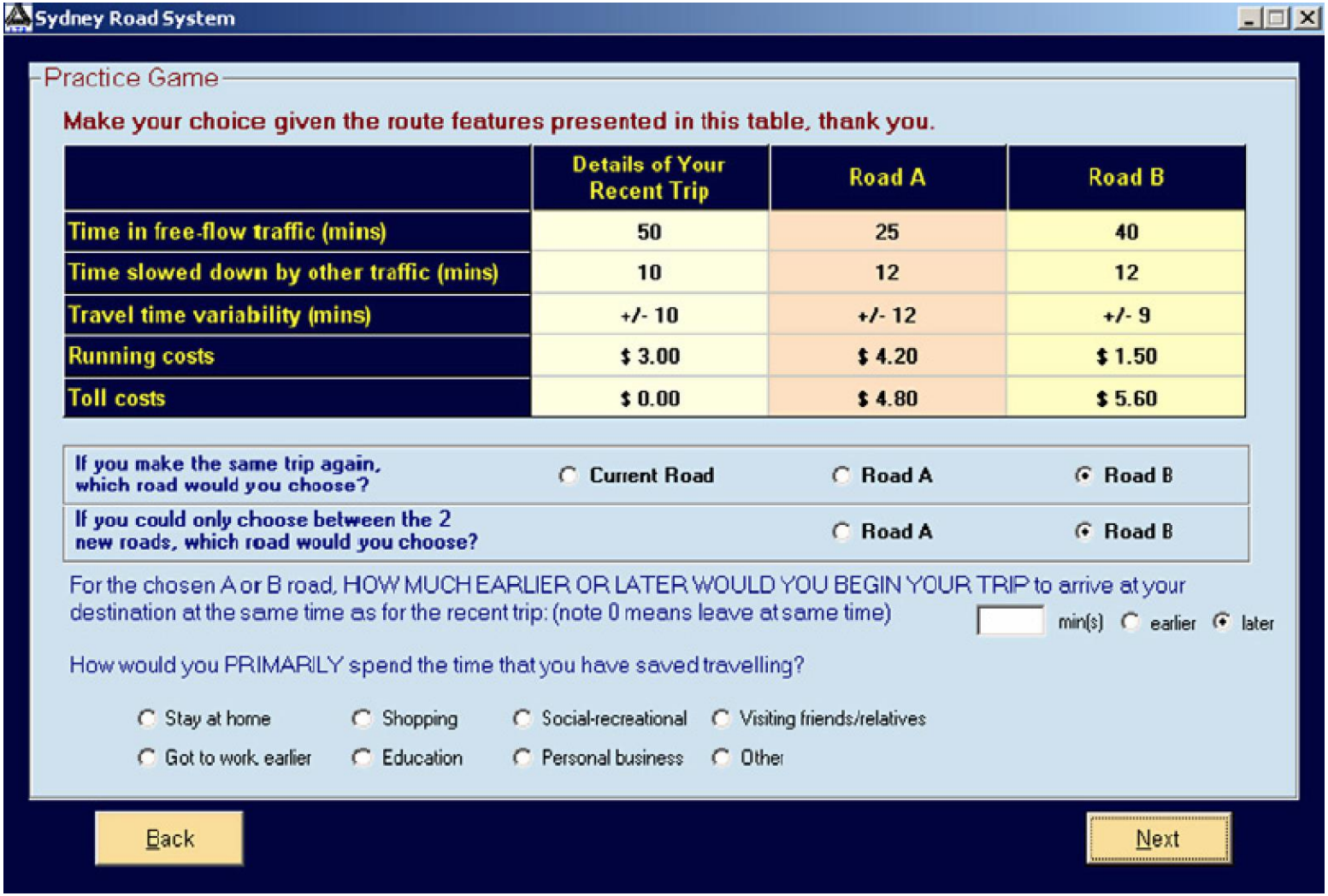
69%

$0.14

31%



Zero cost example: Toll road



Source: Hess, Rose and Hensher (2008)

Zero cost example: Environmental economics

Source: Dekker (20XX)

Choice sets

- Choice sets (especially in environmental valuations)
  - ’Status quo’ / ‘Do nothing’ alternative
    - **zero cost** to maintain status quo
    - Required for calculation of welfare measures (Boyle et al., 2001)
  - ‘Stated Preference’/ ‘Intervention’ alternatives
    - **non-zero costs** to pay for different levels of improvements
- This study attempts to demonstrate that such setting could lead to biased WTP estimates

Reasons for biased WTP estimates

- Theoretical rationale of bias
  - Zero-price effect
  - Certainty effect
- Technical estimation issues
  - Confounding due to model misspecifications
  - Confounding with cost sensitivites

Zero-price effect

- Zero is a 'special' value - Affective feeling towards free products and additional benefits perceived
- Demonstrated in the experiment of chocolate choices between Hershey's and Ferrero Rocher (Shampanier, Mazar and Ariely, 2007)
- Under examined within the context of discrete choice modelling
- Representation in utility formulation

$$V_{sq} = ASC_{status\_quo} + ASC_{zero\_price}\,(Cost_{sq} == 0)$$

$$V_{sp_{1,2}} = \beta_{C_{sp_{1,2}}} Cost_{sp_{1,2}} + \beta_{T_{sp_{1,2}}} Time_{sp_{1,2}}$$

Special value of zero as certainty effect

- Zero value does not always increase attractiveness
- Stathopoulos and Hess (2012) investigates the non-linearities in the rate of crowding and delays using piece-wise linear approximation approach
  - Much higher WTP for 0% risk crowding compared to a 10% risk of crowding
    - Resembles the pro-certainty effect for gains (Tversky and Kahneman, 1986)
  - Much higher WTA at 100% risk of delays compared to 90% risk of delays
    - Could be interpreted as extremeness aversion
    - Strong preference to avoid sure loss, exact opposite implication of certainty effect
- Responses to zero-value thus vary depending on the nature of the attribute
- It also highlights the importance of capturing non-linearities near zero

Confounding due to misspecifications

- Imagine in the extreme case when there is no status quo effect
- Zero-price constant might confound with other effects due to model misspecifications
- Some common misspecifications include the situation when analysts use linear model only at presence of non-linear cost sensitivities
  - Non-linear cost sensitivities would be captured by the zero-price constants
  - Demonstrated by using simulated data
- Bring attention to the extensive research on incorporating non-linear cost sensitivity from transport research (Daly, 2010; Rich and Mabit,2016)

Confounding with cost sensitivities

- Zero-price constant can also capture cost sensitivity leading to understated cost sensitivity and inflated WTP measures (Hess and Beharry-Borg, 2012)
- With SQ alternative contains constants only, there is insufficient information to distinguish whether respondents choosing the SQ alternative is due to the price sensitivity or the strategic bias/protest behaviour
- Effect is more apparent in models with non-linear sensitivities

Study objectives and survey design

Study objectives

- Some research questions raised from these issues
  - Can we find evidence of zero-price effects within discrete choice modelling context?
    - Require us to disentangle the zero-price effects from status-quo effects
  - Is it only the zero-price that is a special value?
    - Can we also capture the non-linearities for small values near zero
  - Any improvements in the SC design to allow us to minimize the issues related to zero-price effects?
- To design a set of SC experiments that allows us to disentangle the status quo effects, zero price effects and explore non-linearities

Survey instrument

- Collected responses from students at the University of Warsaw
- A typical environmental non-market valuation survey for students might not be realistic to students in particular for analysing zero-price effects
- Better to ask students on making choices for something relevant yet largely affordable
- A set of 3 stated choice experiments to be answered by same respondent
- Complemented by Monte Carlo simulation

4G data package choices - Features

- Status quo – Free Wi-Fi within campus
- National 4G coverage of fast internet outside campus
- Secure and full access to the university network anywhere
- Could also share the broadband network connection with up to 3 devices in total

Stated choice survey designs

Design	Alt	Wifi access (On campus)	4G package for outside campus		
		Monthly cost (zloty)	Monthly Cost (zloty)	Data limit (GB per month)	Accessible for multiple devices
1	SQ	0 zł	-	-	-
	SP1/2	0 zł	5 zł / 10 zł / 15 zł / 20 zł / 30 zł / 40 zł	3GB / 5GB / 10GB / 20GB	Yes / No
2	SQ	0 zł / 2 zł / 4 zł	-	-	-
	SP1/2	0 zł / 2 zł / 4 zł	5 zł / 10 zł / 15 zł / 20 zł / 30 zł / 40 zł	3GB / 5GB / 10GB / 20GB	Yes / No
3	SP1/2	-	0 zł / 1 zł / 2 zł / 3 zł / 4 zł / 5 zł / 8 zł / 10 zł / 20 zł / 30 zł	3GB / 5GB / 10GB / 20GB	Yes / No

Stated choice survey – Sample questionnaire I

- SC Design 1 – Zero-cost SQ alternative

B1 #1		Current Service Level	Alternative B	Alternative C
Unlimited Wi-Fi on campus	Monthly cost	0 zł	0 zł	0 zł
4G data package outside campus	Monthly cost	-	5 zł	15 zł
	Monthly data limit	-	5 GB	20 GB
	Accessible by multiple devices?	-	No (1 device only)	Yes (up to 3 devices)
	Choose one:			

Stated choice survey – Sample questionnaire II

- SC Design 2 – Zero or Non-zero cost SQ alternative

B1 #6		Current Service Level	Alternative B	Alternative C
Unlimited Wi-Fi on campus	Monthly cost	4 zł	4 zł	4 zł
4G data package outside campus	Monthly cost Monthly data limit Accessible by multiple devices?		10 zł 3 GB No (1 device only)	20 zł 20 GB No (1 device only)
	Choose one:			

Stated choice survey – Sample questionnaire III

- SC Design 3 – Forced trade-offs

B1 #2

4G data package outside campus	**Alternative A**	**Alternative B**
Monthly cost	10 zł	2 zł
Monthly data limit	20 GB	3 GB
Accessible by multiple devices?	No (1 device only)	Yes (up to 3 devices)
Choose one:		

Part 1: Simulation results

Simulated data generating process

- Key purposes
  - To demonstrate the potential issues due to model misspecifications
  - To test whether the Design 2 would help reducing bias related to zero-cost SQ alternatives when compared to Design 1
- Simulation steps
  - Set out model specification
  - Simulate choice probabilities for 500 respondents using experimental designs 1 and 2
  - Estimate model parameters based on the simulated data set
  - Take average of estimated parameters of 100 random iterations

Tests for model misspecifications I

- Full specification (as in Case 4)

$$V_{sq} = \boldsymbol{ASC\_zp_{sq}(Cost_{sq} == 0)}$$

$$V_{sp_{1,2}} = \beta_{lC_{sp_{1,2}}} Cost_{sp_{1,2}} + \beta_{lnC_{sp_{1,2}}} \ln(Cost_{sp_{1,2}})$$

$$+ \beta_{D_{sp_{1,2}}} DataLimit_{sp_{1,2}} + \beta_M (MultiDevice_{sp_{1,2}} == 0)$$

- Marginal willingness-to-pay depends on the cost attribute as it takes in log cost form in full specification:

$$MWTP_{DataLimit} = \frac{\partial V / \partial DataLimit}{\partial V / \partial Cost} = \frac{\beta_{DataLimit}}{\beta_{lC} + \beta_{lnC}\left(\frac{1}{Cost}\right)}$$

- Assumed Cost: 10ztly

Tests for model misspecifications II

- Log functional form for this test – applied for any costs greater than 0
- Simulated data for 4 cases with 16 combinations for experimental designs 1 and 2 (i.e., 32 combinations in total)

True model		
Cost (All alts)		ASC (SQ alts only)
Linear Cost	-	-
Linear Cost	-	Zero price ASC
Linear Cost	Log Cost	-
Linear Cost	Log Cost	Zero price ASC

Simulated dataset			
Linear Cost	Linear Cost	Linear Cost	Linear Cost
-	-	Log Cost	Log Cost
-	Zero price ASC	-	Zero price ASC

Tests for model misspecifications II

- Many different non-linear functions – log functional form for this test
- Simulated data for 4 cases with 16 combinations for experimental designs 1 and 2 (i.e., 32 combinations in total)

True model			Simulated dataset			
Cost (All alts)		ASC (SQ alts only)	Linear Cost	Linear Cost	Linear Cost	Linear Cost
			-	-	Log Cost	Log Cost
			-	Zero price ASC	-	Zero price ASC
Linear Cost	-	-				
Linear Cost	-	Zero price ASC				
Linear Cost	Log Cost	-				
Linear Cost	Log Cost	Zero price ASC				

- Model replication

Tests for model misspecifications II

- Many different non-linear functions – log functional form for this test
- Simulated data for 4 cases with 16 combinations for experimental designs 1 and 2 (i.e., 32 combinations in total)

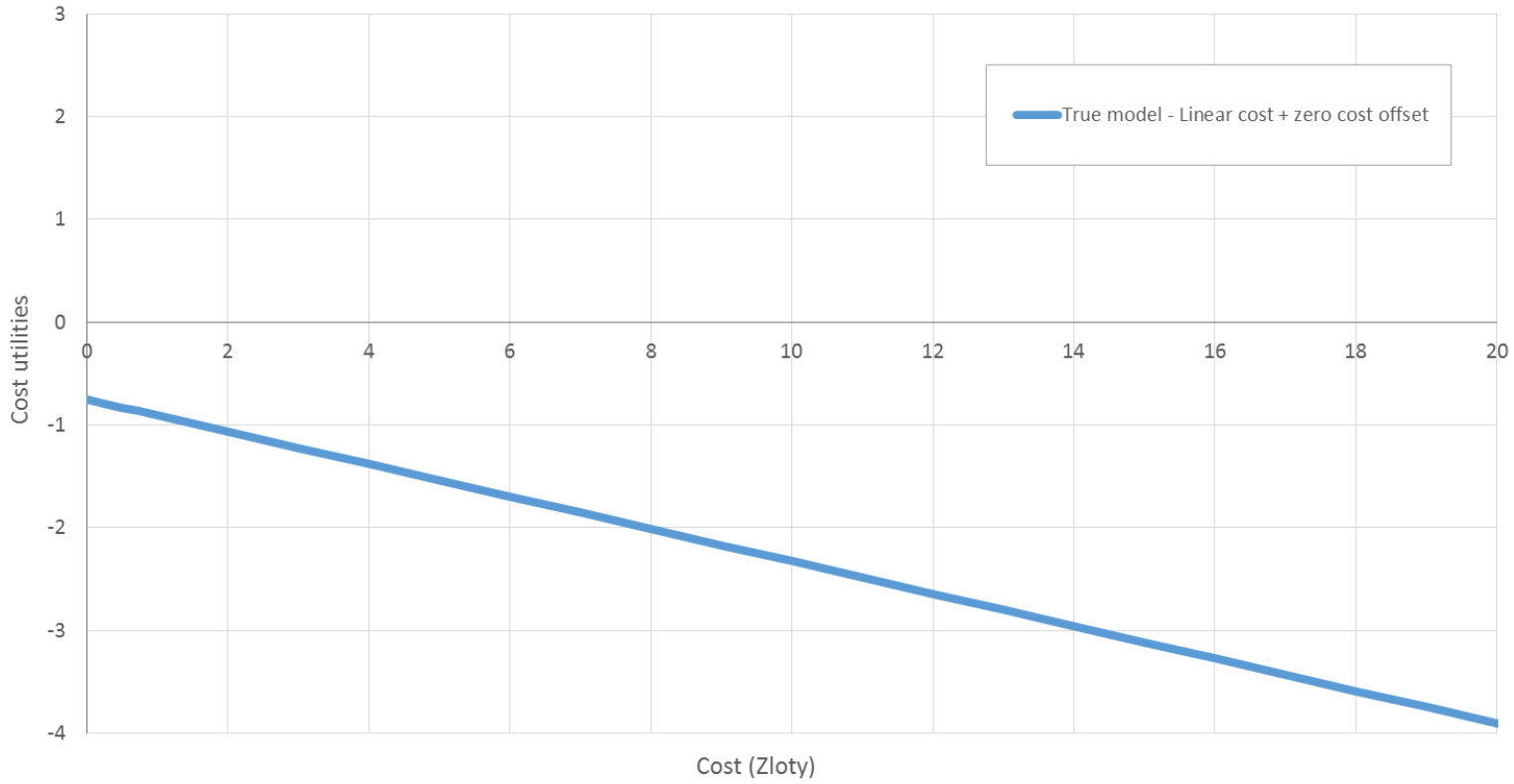
True model			Simulated dataset			
Cost (All alts)		ASC (SQ alts only)	Linear Cost	Linear Cost	Linear Cost	Linear Cost
			-	-	Log Cost	Log Cost
			-	Zero price ASC	-	Zero price ASC
Linear Cost	-	-				
Linear Cost	-	Zero price ASC				
Linear Cost	Log Cost	-				
Linear Cost	Log Cost	Zero price ASC				

- Sample cases of model misspecifications

Case 1 - Linear model with zero-price effects I

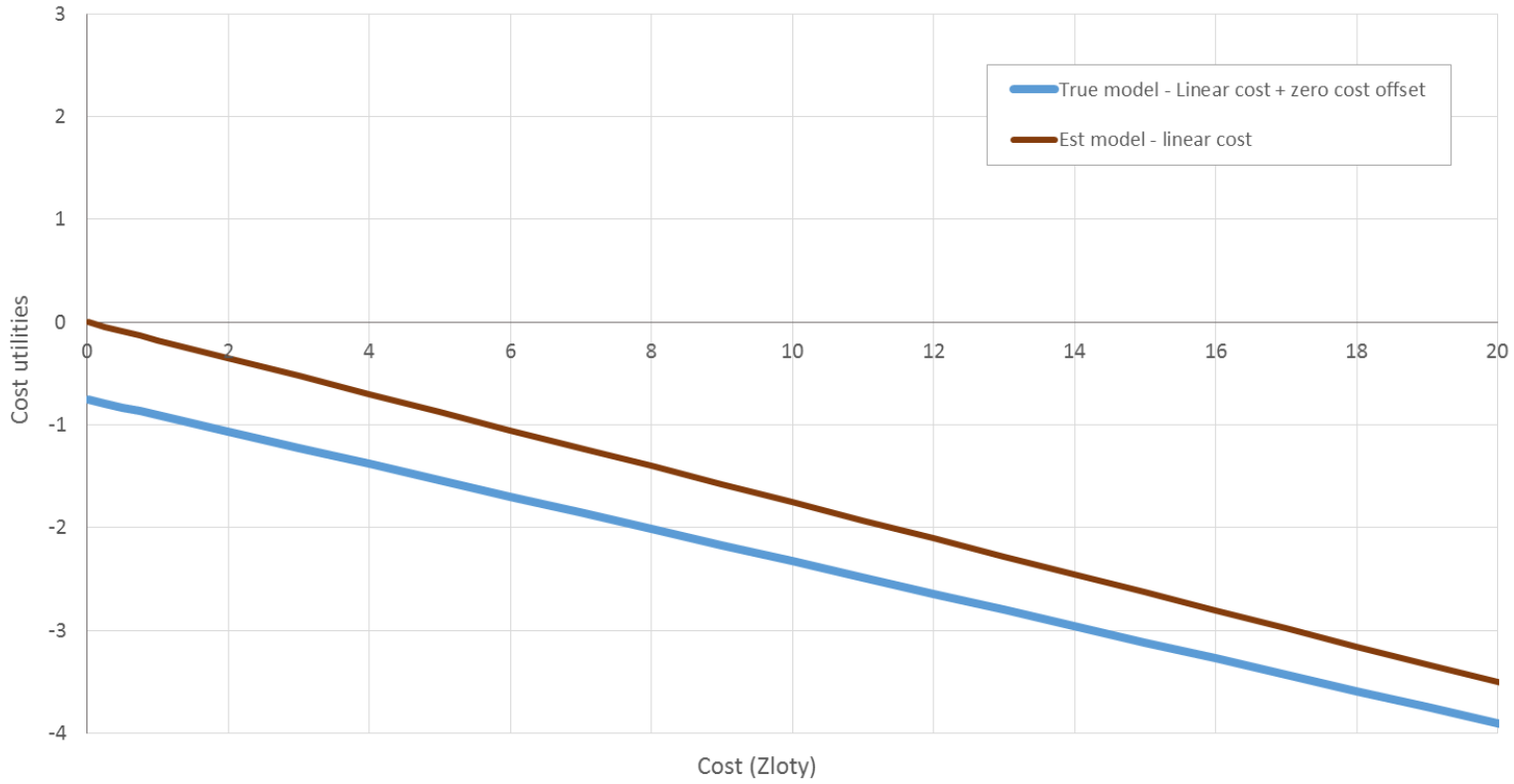
Estimated with same model specification

Marginal willingness-to-pay for 1GB of data limit: +1%



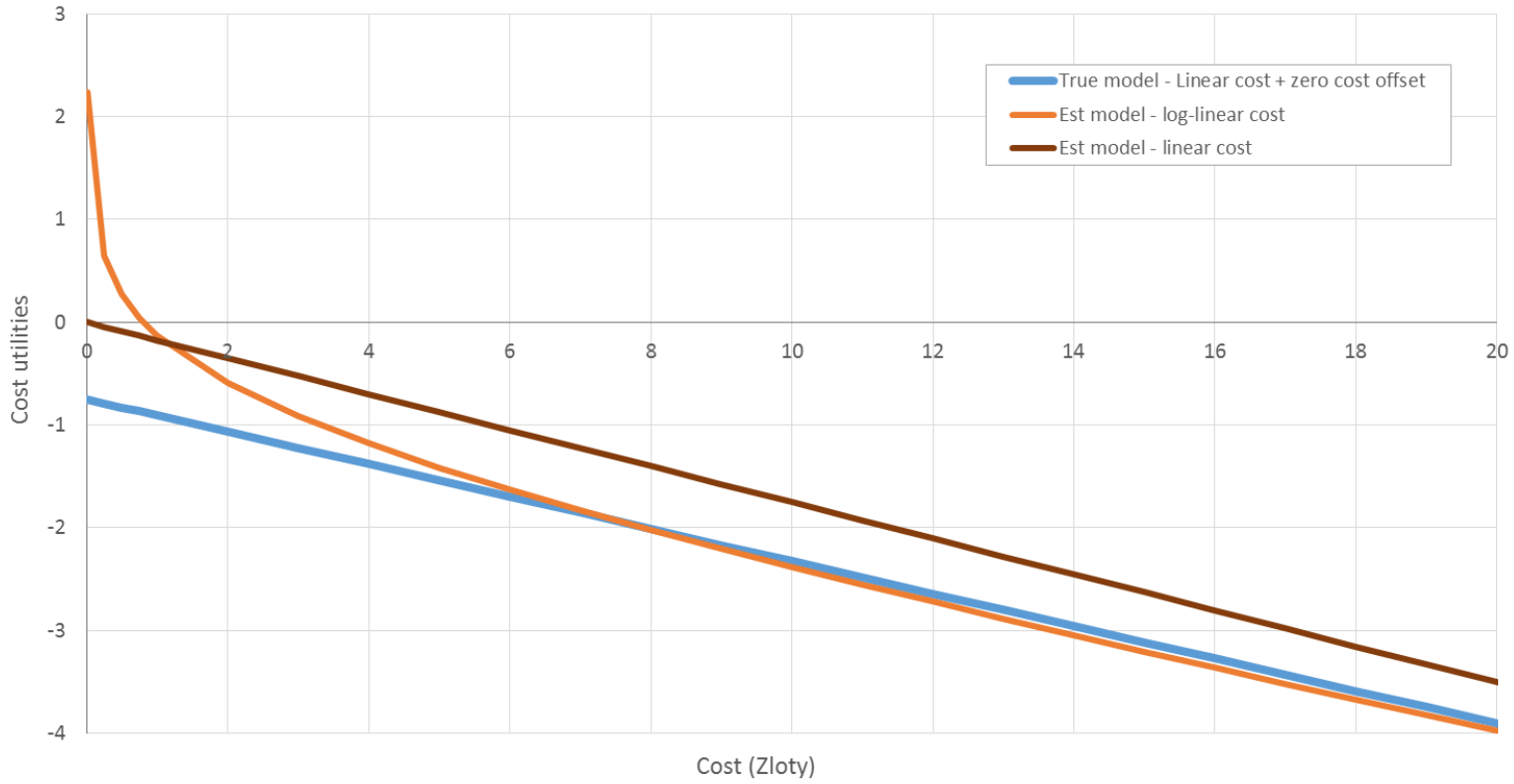
Case 1 - Linear model with zero-price effects II

Estimated with linear costs only, ignoring the zero-price effects
Marginal willingness-to-pay for 1GB of data limit : -26%



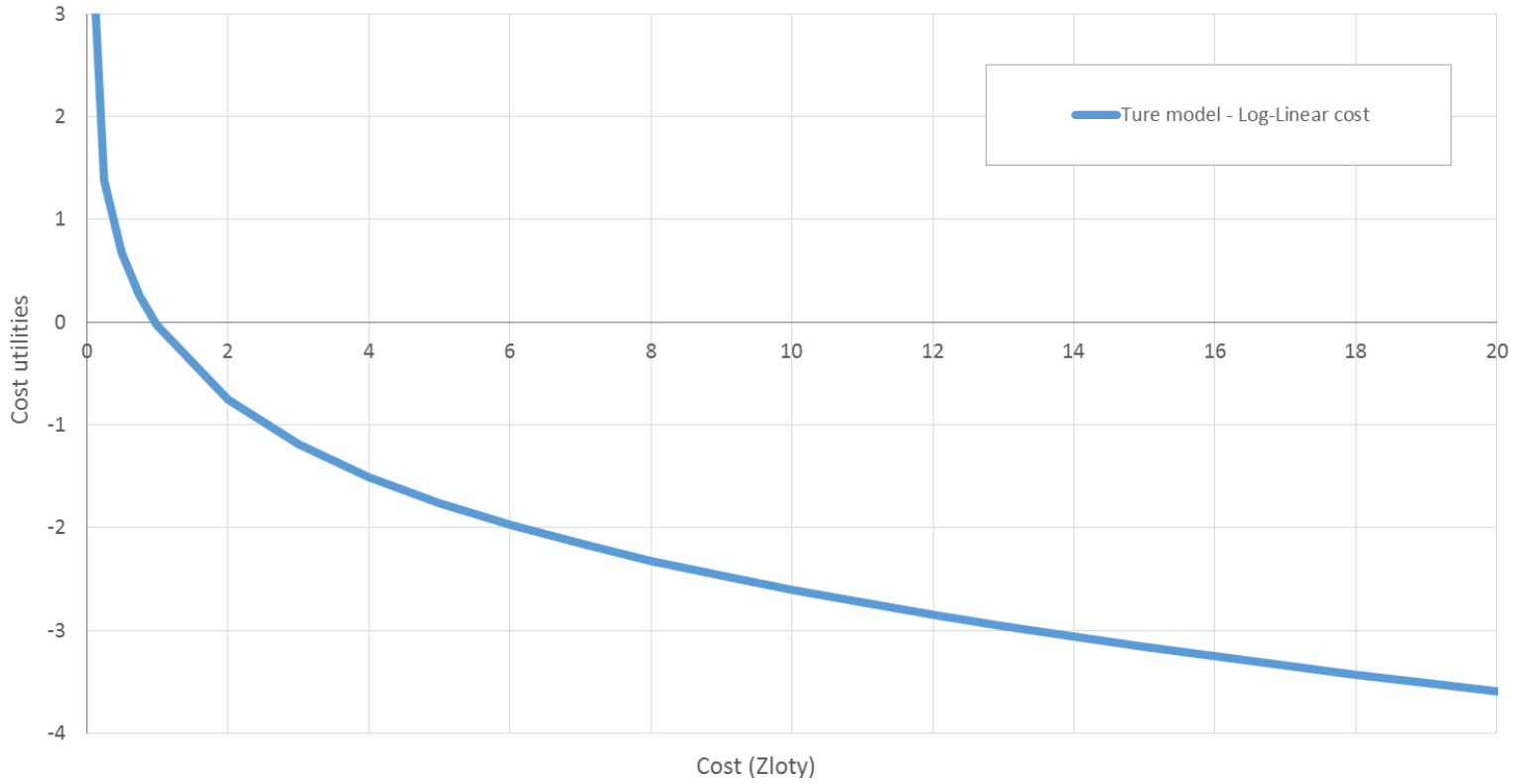
Case 1 - Linear model with zero-price effects III

Estimated with log and linear costs without zero-price constants
Marginal willingness-to-pay for 1GB of data limit : -6%



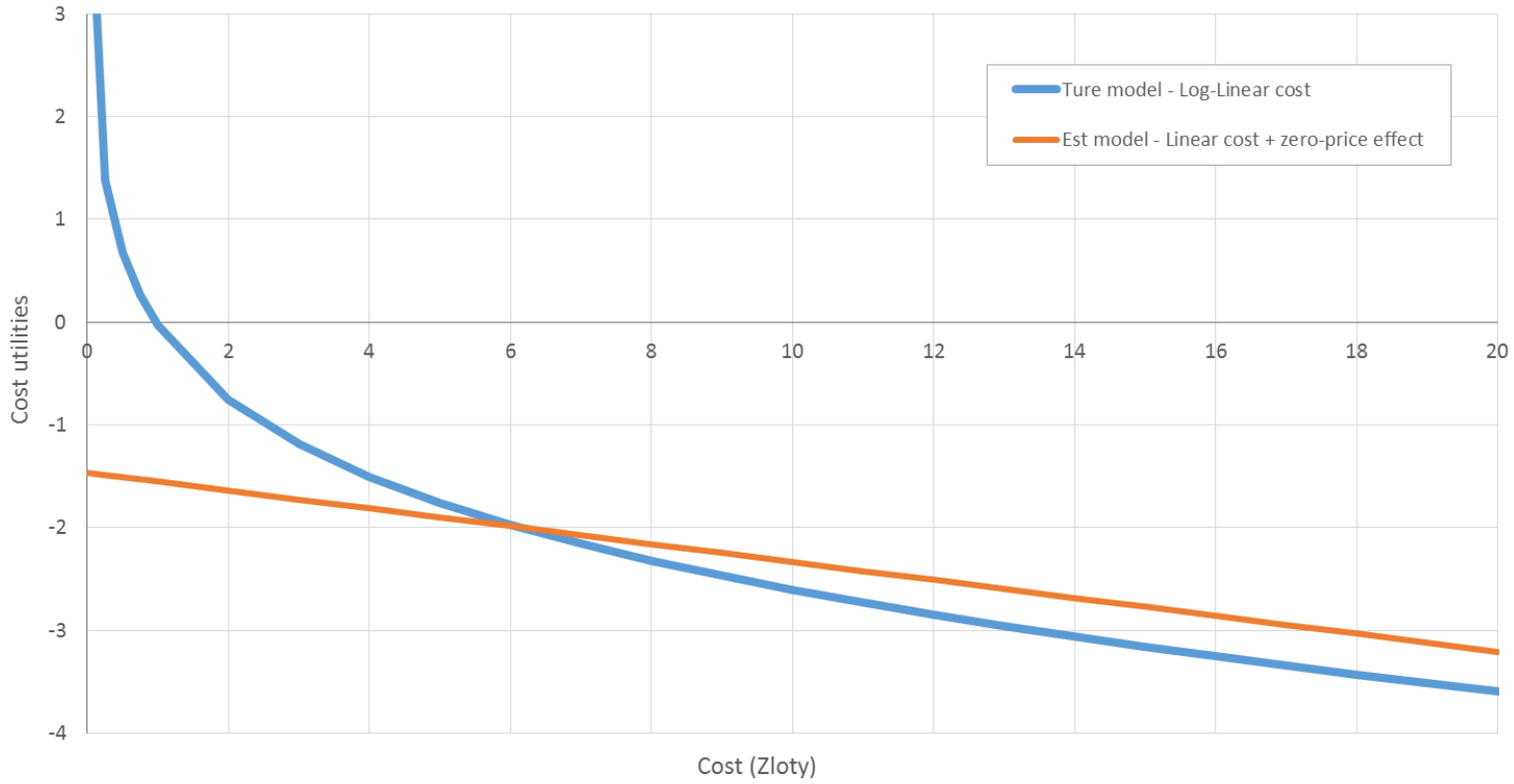
Case 2 - Log-Linear model w/o zero-price effects I

Conversely, there could be situation when there are non-linearities within the data but without zero-price effects



Case 3 - Log-Linear model w/o zero-price effects

But the non-linearity was misinterpreted as zero-price effects and estimated by a linear cost with zero-price constant. MWTP for 1GB of data limit: +26%



Tests for model misspecifications

- Same impacts as status quo effect alone

MWTP diff vs. True Model		SP Alts	Linear Cost	Linear Cost	Linear Cost	Linear Cost
			-	-	Log Cost	Log Cost
SP Alts		SQ Alts	-	Zero price ASC	-	Zero price ASC
Linear Cost	-	-	0%	0%	0%	-1%
Linear Cost	-	Zero price ASC	-26%	1%	-6%	0%
Linear Cost	Log Cost	-	-44%	26%	0%	0%
Linear Cost	Log Cost	Zero price ASC	-60%	25%	-18%	-1%

Test again with Design 2

- It appears that Design 2 have tighten the gap between estimated and true models
- Results confirm the issue with model misspecification
- Also highlights the need to try more flexible utility specification

Stated Choice Design #	MWTP diff vs. True Model		SP Alts	Linear Cost	Linear Cost	Linear Cost	Linear Cost
				-	-	Log Cost	Log Cost
	SP Alts		SQ Alts	-	Zero price ASC	-	Zero price ASC
Design 1 Zero-cost SQ Alt	Linear Cost	-	Zero price ASC	-26%	1%	-6%	0%
	Linear Cost	Log Cost	Zero price ASC	-60%	25%	-18%	-1%
Design 2 Zero and non-Zero-cost SQ Alt	Linear Cost	-	Zero price ASC	-10%	0%	2%	0%
	Linear Cost	Log Cost	Zero price ASC	-22%	6%	-8%	0%

Part 2: Stated choice survey results

Pilot survey undertaking

- Late March 2017
- Efficient design
- 80 individuals
- 1920 observations for all 3 designs
- Analysed with MNL with panel effects

Design 1 – Standard SC setup

- Best model: Linear cost with SQ x ZP ASC

	Linear cost		Linear cost SQ x ZP ASC		Loglinear cost		Loglinear cost SQ x ZP ASC	
Decision makers	80		80		80		80	
Observations	640		640		640		640	
Final LL	-611.3		-606.9		-607.4		-606.9	
Est Par	3		4		4		5	
Adj. rho-sq	0.13		0.13		0.12		0.13	
Parameter estimates	Est	t-stat	Est	t-stat	Est	t-stat	Est	t-stat
Linear cost	-0.086	-11.6	-0.073	-8.5	-0.057	-4.5	-0.071	-3.7
Log cost					0.340	-2.4	-0.029	-0.1
Data limit	0.084	7.9	0.092	8.2	0.096	8.8	0.092	9.3
Multiple devices	0.501	3.8	0.782	5.3	0.747	5.4	0.782	5.3
constant			0.636	2.3			0.588	0.8
Zero price constant								
Willingness-to-pay								
Data limit	0.98	8.0	1.26	6.9	4.12		1.24	
Multiple devices	5.81	3.7	10.76	4.3	32.06		10.54	

Design 2 – Reduced zero-price effect

- Best model: Linear cost (WTP for Data 1.02 vs 1.26 of Design 1)

	Linear cost		Linear cost SQ & ZP ASC		Loglinear cost		Loglinear cost SQ & ZP ASC	
Decision makers	80		80		80		80	
Observations	480		480		480		480	
Final LL	-438.3		-438.0		-437.7		-435.3	
Est Par	3		5		4		6	
Adj. rho-sq	0.16		0.16		0.16		0.16	
Parameter estimates	Est	t-stat	Est	t-stat	Est	t-stat	Est	t-stat
Linear cost	-0.10	-8.6	-0.10	-8.1	-0.09	-5.8	-0.06	-3.5
Log cost					-0.13	-1.0	-0.72	-3.5
Data limit	0.11	6.7	0.10	6.1	0.11	7.2	0.11	6.0
Multiple devices	0.37	2.7	0.35	2.6	0.42	3.3	0.31	2.2
Status quo constant			-0.14	-0.5			-0.73	-2.3
Zero price constant			0.14	0.9			-0.44	-1.8
Willingness-to-pay								
Data limit	1.07	8.6	1.02	6.0	1.07		0.80	
Multiple devices	3.59	2.9	3.35	2.6	3.92		2.33	

Design 3 – Forced trade-offs

- Best model: Loglinear cost

	Linear cost		Linear cost ZP ASC		Loglinear cost		Loglinear cost ZP ASC	
Decision makers	80		80		80		80	
Observations	800		800		800		800	
Final LL	-423.5		-420.3		-411.7		-411.3	
Est Par	3		4		4		5	
Adj. rho-sq	0.23		0.23		0.25		0.25	
Parameter estimates	Est	t-stat	Est	t-stat	Est	t-stat	Est	t-stat
Linear cost	-0.14	-9.9	-0.14	-9.7	-0.08	-4.7	-0.09	-4.7
Log cost					-0.64	-4.9	-0.60	-4.2
Data limit	0.07	5.5	0.08	6.3	0.09	8.0	0.09	8.2
Multiple devices	0.55	5.6	0.46	4.5	0.40	4.1	0.38	3.6
Status quo constant								
Zero price constant			0.46	2.4			0.18	0.8
Willingness-to-pay								
Data limit	0.48	6.1	0.56	7.0	0.62		0.64	
Multiple devices	3.97	4.9	3.36	4.1	2.78		2.62	

Conclusions and next steps

Discussions based on pilot survey results

- Reckon the lack of information within pilot survey data for detecting non-linearities and zero-price effects
- Evidence of zero-price effects?
  - Not from Design 3 – Non-linearities instead
  - Too many small values?
- Confounding issues?
  - Necessary to test different flexible model specifications for robust welfare estimation
  - No zero's in the SP alternatives for now, should we introduce dominant choices to add information for model?

Conclusions and next steps

- Priors feeding back into full survey
- Joint model utilising trade-offs from all designs
- Try different non-linearity functions (Box-cox transformations, piece-wise linear approximations, power series expansions)
- Explore non-linearities for other non-cost attributes
- Explore heterogeneity


ANY
QUESTIONS
?