Modelling Port choice: analysis of shipments from the hinterland of the Spanish ports

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Outline

Outline

Line of research

Goaport: *Go ahead port!*

- Analysis from the point of view of inter-port competition.
- Discrete choice models.
- Case study: main container Spanish peninsular ports (Algeciras, Barcelona, Valencia and Bilbao).

Foreign Trade Statistics

Variables:

- Import and export operations by transport mode.
- Province of origin/destination of the goods.
- The customs office.
- Country of destination/origin.
- Goods classified according to the Combined Nomenclature (CN).
- Weight and value of goods.
- Incoterms (*international commercial terms*).

The Tax Agency. Customs and Special Taxes.
`http://www.agenciatributaria.es`

Dataset

- Container traffic. Flows with outside. Peninsular provinces.
- Years: 2004 - 2012. Exports –> sample size about 6 million observations.

Background

Garcia-Alonso, L., Martinez-Pardo, A., Vallejo-Pinto, J.A., 2016. Analysis of the spatial development of the hinterland of ports: a case study. *Int. J. Shipp. Transp. Logist.* 8, 111-128. doi:10.1504/IJSTL.2016.075007

This paper:

- Analyses the evolution of the hinterland of the main Spanish peninsular container ports during the previous decade (Algeciras, Barcelona, Bilbao and Valencia).
- The hinterland has changed over the decade.

Literature review on port choice with DCM

The study of port choice behaviour is complex because in freight transport, unlike the case of the passenger transport, there are manifold agents involved.

- The nonlinear influence of the variables and the heterogeneity in preferences are both usually ignored problems.
- Heterogeneity in preferences:
  - Limits the study to a single decision-making agent.
  - Characteristics of decision makers (size).

Assumptions usually considered

$$U_{nj} = \underbrace{V_{nj}}_{\text{Observed part}} + \underbrace{\varepsilon_{nj}}_{\text{Error term}}$$

- $\neq$ assumptions $\varepsilon_{nj} \Rightarrow \neq$ DCM
- $V_{nj} = ASC_j + \sum_{k=1}^{K} \beta_k x_{knj}$

Multinomial logit

- Independence from irrelevant alternatives, IIA property: same substitution ratio between all alternatives.
- Same preference across all decision makers.
- Independent errors between observations.

Nested Logit $\Rightarrow$ Alternatives grouped by nests (relax IIA).

Port Reality

- More substitution ratio from near ports or with equal specialization.
- $\neq$ same preference across all decision makers.
- The same agent can make multiple shipments.
- Nonlinear influence of attributes.

Main problems

Heterogeneity in preferences$\Rightarrow$

- Mixed Logit
  - Random taste variation.
  - Correlation across alternatives and observations.
  - Heteroscedasticity ($\neq$ variance in the error term).

Nonlinear specification

- Several transformations (logarithms, powers) | categorical variables.
- Box-Cox transformation: the BC transformation allow the data themselves to obtain the optimal form of the non-linear utility $\rightarrow$ Box-Cox logit models.

Outline

Box-Cox Mixed Logit

- This research deal with the issue of considering heterogeneous preferences and non-linearity in variables in the scope of port choice.
- This has not been usually considered. So far, Those matters really exists? Is it necessary to take it into account?

$$U_{nj} = ASC_j + \sum_{k=1}^{K} \beta_{knj} x_{knj}^{(\lambda_k)} + \varepsilon_{nj}$$

$$\beta_{knj} \sim \; f(\beta|\theta)$$

$$x_{knj}^{(\lambda_k)} = \begin{cases} \frac{x_{knj}^{\lambda_k} - 1}{\lambda_k} & if \quad \lambda_k \neq 0 \\ ln(x_{knj}) & if \quad \lambda_k = 0 \end{cases}$$

$$\varepsilon_{nj} \sim \; Gumbel\ iid.$$

Variables

Variable	Definition
DO_{nj}	Distance by road between port j and province of origin of shipping n
DD_{nj}	Distance for shipping n by maritime routes between port j and country of destination
$CR_j(t)$	Number of STS gantry cranes at port j for each year t
$TC_j(t-1)$	Degree of use of port facilities indicator, at port j for each year $t-1$

- $DD_{nj} \Rightarrow$ the mean of the most frequently routes according to the Freight Exchange platform. `www.searates.com`
- $TC_j(t-1) \Rightarrow$ Port performance indicators

$$TC_j(t) = \frac{TEU_j(t)}{CR_j(t)}$$

Proposed specifications

- Multinomial logit (MNL)

$$U_{nj} = ASC_j + \beta_{DO} * DO_{nj} + \beta_{DD} * DD_{nj} + \beta_{CR} * CR_j(t) + \sum_{q=1}^{Q} \beta_{TC}^{q} * TC_j^{q}(t-1) + \varepsilon_{nj}$$

- Mixed logit (ML)

$$\beta_{DO} \sim \mathcal{N}(\mu_{DO}, \sigma_{DO}^2), \beta_{DD} \sim \mathcal{N}(\mu_{DD}, \sigma_{DD}^2)$$

- Box-Cox logit (BCL)

$$DO_{nj}^{(\lambda_{DO})}, DD_{nj}^{(\lambda_{DD})}$$

- Box-Cox mixed logit (BCML)

$$\begin{cases} U_{nj} = & ASC_j + (\mu_{DO} + \sigma_{DO} * \xi_{DOn}) * \frac{DO_{nj}^{\lambda_{DO}} - 1}{\lambda_{DO}} + (\mu_{DD} + \sigma_{DD} * \xi_{DDn}) * \frac{DD_{nj}^{\lambda_{DD}} - 1}{\lambda_{DD}} + \\ & + \beta_{CR} * CR_j(t) + \sum_{q=1}^{Q} \beta_{TC}^{q} * TC_j^{q}(t-1) + \varepsilon_{nj} \qquad if \quad \lambda_k \neq 0 \\ & \\ U_{nj} = & ASC_j + (\mu_{DO} + \sigma_{DO} * \xi_{DOn}) * \ln(DO_{nj}) + (\mu_{DD} + \sigma_{DD} * \xi_{DDn}) * \ln(DD_{nj}) + \\ & + \beta_{CR} * CR_j(t) + \sum_{q=1}^{Q} \beta_{TC}^{q} * TC_j^{q}(t-1) + \varepsilon_{nj} \qquad if \quad \lambda_k = 0 \end{cases}$$

Outline

	MNL					ML			
Parameter (variable unit)	Value	*Rob Std. error*	*Rob t-test*	*p-value*		Value	*Error Std. rob.*	*Rob t-test*	*p-value*
ASC_{ALG}	-1.47	0.01	-132.76	0.00		-3.19	0.03	-118.65	0.00
ASC_{BAR}	0.00					0.00			
ASC_{BIL}	-7.92	0.07	-114.99	0.00		-22.30	0.13	-177.04	0.00
ASC_{VAL}	-0.56	0.01	-96.71	0.00		-0.94	0.01	-116.64	0.00
β_{CR} $(10^3\ ud)$	5.93	0.82	7.21	0.00		7.80	1.14	6.83	0.00
β_{DO} $(10^3\ km)$	-6.86	0.01	-844.58	0.00	μ_{DO}	-12.90	0.05	-260.90	0.00
					σ_{DO}	6.00	0.03	176.94	0.00
β_{DD} $(10^4\ km)$	-7.98	0.09	-87.03	0.00	μ_{DD}	-10.40	0.16	-65.59	0.00
					σ_{DD}	38.00	0.31	124.33	0.00
β_{TC}^{A}	-0.31	0.13	-2.31	0.02		-0.56	0.20	-2.76	0.01
β_{TC}^{B}	0.00					0.00			
β_{TC}^{C}	0.20	0.01	32.09	0.00		0.34	0.01	38.90	
β_{TC}^{D}	-0.59	0.01	-43.26	0.00		-0.66	0.03	-24.94	0.00
N	1000000					1000000			
MLHS	-					250			
k	9					11			
$(S)LL(\Theta)$	-404586.71					-372608.46			
$\rho^2 \mid \overline{\rho}^2$	0.708 | 0.536					0.731 | 0.573			

Parameter (variable unit)	MNL Value	MNL *Rob Std. error*	MNL *Rob t-test*	MNL *p-value*		ML Value	ML *Error Std. rob.*	ML *Rob t-test*	ML *p-value*
ASC_{ALG}	-1.47	0.01	-132.76	0.00		-3.19	0.03	-118.65	0.00
ASC_{BAR}	0.00					0.00			
ASC_{BIL}	-7.92	0.07	-114.99	0.00		-22.30	0.13	-177.04	0.00
ASC_{VAL}	-0.56	0.01	-96.71	0.00		-0.94	0.01	-116.64	0.00
β_{CR} $(10^3\ ud)$	5.93	0.82	7.21	0.00		7.80	1.14	6.83	0.00
β_{DO} $(10^3\ km)$	-6.86	0.01	-844.58	0.00	μ_{DO}	-12.90	0.05	-260.90	0.00
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β_{DD} $(10^4\ km)$	-7.98	0.09	-87.03	0.00	μ_{DD}	-10.40	0.16	-65.59	0.00
					σ_{DD}	38.00	0.31	124.33	0.00
β^{A}_{TC}	-0.31	0.13	-2.31	0.02		-0.56	0.20	-2.76	0.01
β^{B}_{TC}	0.00					0.00			
β^{C}_{TC}	0.20	0.01	32.09	0.00		0.34	0.01	38.90	
β^{D}_{TC}	-0.59	0.01	-43.26	0.00		-0.66	0.03	-24.94	0.00
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$(S)LL(\Theta)$	-404586.71					-372608.46			
ρ^2 | $\bar{\rho}^2$	0.708 | 0.536					0.731 | 0.573			

Parameter (variable unit)	BCL					BCML			
	Value	*Error Std. rob.*	*Rob t-test*	*p-value*		Value	*Error Std. rob.*	*Rob t-test*	*p-value*
ASC_{ALG}	-1.63	0.01	-139.14	0.00		-2.41	0.02	-138.80	0.00
ASC_{BAR}	0.00					0.00			
ASC_{BIL}	-7.87	0.07	-113.81	0.00		-14.60	0.10	-153.05	0.00
ASC_{VAL}	-0.37	0.01	-62.48	0.00		-0.72	0.01	-95.75	0.00
β_{CR} (10^3 ud)	2.93	0.84	3.49	0.00		3.75	1.04	3.61	0.00
β_{DO} (10^3 km)	-3.70	0.01	-267.18	0.00	μ_{DO}	-5.11	0.03	-166.19	0.00
					σ_{DO}	2.41	0.02	154.20	0.00
λ_{DO}	0.58	0.00	290.23	0.00		0.46	0.00	107.01	0.00
β_{DD} (10^4 km)	-3.64	0.08	-42.93	0.00	μ_{DD}	-5.61	0.11	-49.70	0.00
					σ_{DD}	6.67	0.17	39.91	0.00
λ_{DD}	0.25	0.01	39.52	0.00		0.41	0.01	72.46	0.00
β_{TC}^{A}	-0.34	0.13	-2.60	0.01		-0.82	0.14	-5.79	0.00
β_{TC}^{B}	0.00					0.00			
β_{TC}^{C}	0.20	0.01	30.46	0.00		0.30	0.01	38.33	0.00
β_{TC}^{D}	-0.32	0.01	-22.87	0.00		-0.21	0.02	-11.08	0.00
N	1000000					1000000			
MLHS	-					250			
k	11					13			
$(S)LL(\Theta)$	-368656.88					-353602.90			
ρ^2 | $\overline{\rho}^2$	0.734 | 0.577					0.735 | 0.595			

Parameter (variable unit)	BCL Value	BCL Error Std. rob.	BCL Rob t-test	BCL p-value		BCML Value	BCML Error Std. rob.	BCML Rob t-test	BCML p-value
ASC_{ALG}	-1.63	0.01	-139.14	0.00		-2.41	0.02	-138.80	0.00
ASC_{BAR}	0.00					0.00			
ASC_{BIL}	-7.87	0.07	-113.81	0.00		-14.60	0.10	-153.05	0.00
ASC_{VAL}	-0.37	0.01	-62.48	0.00		-0.72	0.01	-95.75	0.00
β_{CR} (10^3 ud)	2.93	0.84	3.49	0.00		3.75	1.04	3.61	0.00
β_{DO} (10^3 km)	-3.70	0.01	-267.18	0.00	μ_{DO}	-5.11	0.03	-166.19	0.00
					σ_{DO}	2.41	0.02	154.20	0.00
λ_{DO}	0.58	0.00	290.23	0.00		0.46	0.00	107.01	0.00
β_{DD} (10^4 km)	-3.64	0.08	-42.93	0.00	μ_{DD}	-5.61	0.11	-49.70	0.00
					σ_{DD}	6.67	0.17	39.91	0.00
λ_{DD}	0.25	0.01	39.52	0.00		0.41	0.01	72.46	0.00
β^A_{TC}	-0.34	0.13	-2.60	0.01		-0.82	0.14	-5.79	0.00
β^B_{TC}	0.00					0.00			
β^C_{TC}	0.20	0.01	30.46	0.00		0.30	0.01	38.33	0.00
β^D_{TC}	-0.32	0.01	-22.87	0.00		-0.21	0.02	-11.08	0.00
N	1000000					1000000			
MLHS	-					250			
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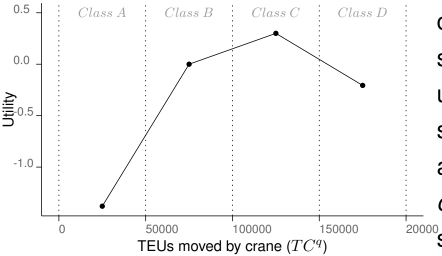
$(S)LL(\Theta)$	-368656.88					-353602.90			
ρ^2 | $\overline{\rho}^2$	0.734 | 0.577					0.735 | 0.595			

Level of use of port facilities vs utility of the port (BCML)



The more traffic a port has, the more attractive it becomes because of the economies of agglomeration, scale and network effects but only up to a certain point when the port starts to be saturated. From there, as port traffic continues to grow, *ceteris paribus*, its attractiveness starts to decrease due the negative consequences of saturation.

Martínez-Pardo, A., Garcia-Alonso, L., Orro, A., 2017. (in press) The role of the degree of use of the facilities in the port choice process: the Spanish dockside cranes case. *Int. J. Shipp. Transp. Logist.*

The **validation** process assures that the observed elections in a sample different from the one used to estimate the model are consistent with the probabilities predicted by the calibrated model ⇒ Validation sample: 25000 observations

1. Average Probability of the chosen alternative: model over-adjusted to the data.

Type of sample	MNL	ML	BCL	BCML
Estimation	0.7812	0.8022	0.7973	0.8100
Validation	0.7808	0.8018	0.7970	0.8094

2. Goodness of fit test: model consistent with the data.

$$\chi^2 = \sum_{j=1}^{J} \frac{(\hat{N}_j - N_j)^2}{N_j} \qquad [\chi^2]^{J-1}_{95\%} < 7.82$$

j	N_j		$\hat{N}_j$							
Port alternative	Observed values		MNL		ML		BCL		BCML	
Algeciras	1406	5.62%	1422.25	5.69%	1481.27	5.93%	1431.89	5.73%	1446.17	5.78%
Barcelona	13074	52.30%	13032.90	52.13%	13013.00	52.05%	13038.50	52.15%	13076.30	52.31%
Bilbao	12	0.05%	7.68	0.03%	13.65	0.05%	7.60	0.03%	14.30	0.06%
Valencia	10508	42.03%	10537.20	42.15%	10492.10	41.97%	10522.00	42.09%	10463.20	41.85%
Total	25000		25000.03		25000.02		24999.99		24999.97	
		$\tilde{\chi}^2$	2.82		4.33		3.13		1.68	

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$$\chi^2 = \sum_{j=1}^{J} \frac{\left(\hat{N}_j - N_j\right)^2}{N_j} \qquad [\chi^2]^{J-1}_{95\%} < 7.82$$

Port alternative (j)	Observed values (N_j)		MNL ($\hat{N}_j$)		ML		BCL		BCML	
Algeciras	1406	5.62%	1422.25	5.69%	1481.27	5.93%	1431.89	5.73%	1446.17	5.78%
Barcelona	13074	52.30%	13032.90	52.13%	13013.00	52.05%	13038.50	52.15%	13076.30	52.31%
Bilbao	12	0.05%	7.68	0.03%	13.65	0.05%	7.60	0.03%	14.30	0.06%
Valencia	10508	42.03%	10537.20	42.15%	10492.10	41.97%	10522.00	42.09%	10463.20	41.85%
Total	25000		25000.03		25000.02		24999.99		24999.97	
$\tilde{\chi}^2$			2.82		4.33		3.13		1.68	

$\chi^2 < 7.82$ test in other 15 validation samples (also not used for calibration).

	MNL	ML	BCL	BCML
1	5.54	7.18	6.91	4.03
2	6.96	6.11	6.82	3.96
3	2.08	4.60	1.92	1.98
4	4.06	0.44	3.59	0.50
5	2.65	5.30	2.28	1.23
6	1.25	3.15	1.40	1.18
7	1.34	5.58	1.40	3.32
8	3.39	1.09	3.55	0.93
9	2.08	1.26	2.29	1.35
10	5.36	1.13	5.35	0.32
11	5.74	1.83	6.02	0.30
12	1.46	3.56	1.61	1.88
13	7.30	2.27	6.71	0.10
14	1.10	2.15	1.27	1.33
15	2.81	4.19	2.61	2.12

- $\uparrow \chi^2 \Rightarrow$ less plausible is that the null hypothesis is correct.
- $\downarrow \chi^2 \Rightarrow$ greater adjustment of the data to the model.

Model Selection

- The estimated parameters are statistically significant and have the expected sign.
- None of the models are over-specified and all produce consistent predictions.
- The BCML model models better the behavior of the port election:
  - Likelihood ratio test (*LR*).
  - The smallest LL, AIC y BIC.
  - The biggest ρ^2 y $\overline{\rho}^2$.

Models	LL/(S)LL	ρ^2	$\overline{\rho}^2$	AIC	BIC	k	LR	DF	$\chi^2_{99\%}$	Comparative
null	-1386294.361									
cte	-872135.382	0.371				3	-1028317.957	3	11.340	cte - null
MNL	-404586.714	0.708	0.536	809164.428	404648.884	9	-935097.337	6	16.810	MNL - cte
ML	-372608.465	0.731	0.573	745205.930	372684.450	11	-63956.498	2	9.210	ML - MNL
BCL	-368656.889	0.734	0.577	737302.778	368732.874	11	-71859.650	2	9.210	BCL - MNL
BCML	-353602.901	0.745	0.595	707192.802	353692.702	13	-101967.626	4	13.280	BCML - MNL
							-38011.128	2	9.210	BCML - ML
							-30107.976	2	9.210	BCML - BCL

Outline

Scenarios

- Practical implications of adopting BCML versus other models in terms of their predictive capabilities
- 6 Hypothetical Scenarios:
  - Provinces of origin: Madrid and Zaragoza (main provinces of origin of the research database).
  - Destination countries: United States, Brazil and China (main countries of destination of the case study with a sufficiently differentiated geographical position).
- Scenario analysis:
  - Initial scenario.
  - Scenario (A): an $\uparrow$ of the degree of use of the facilities of the port of Valencia.
  - Scenario (B): an $\downarrow$ of the degree of use of the facilities of the port of Valencia.

Initial scenario analysis

Shipment	MNL				ML				BCL				BCML			
	Prob. Alg	Prob. Bar	Prob. Bil	Prob. Val	Prob. Alg	Prob. Bar	Prob. Bil	Prob. Val	Prob. Alg	Prob. Bar	Prob. Bil	Prob. Val	Prob. Alg	Prob. Bar	Prob. Bil	Prob. Val
I	6.30%	14.33%	0.04%	79.33%	6.19%	10.27%	0.00%	83.54%	5.30%	20.93%	0.03%	73.74%	2.91%	17.43%	0.00%	79.66%
II	2.36%	19.72%	0.00%	77.91%	1.49%	12.71%	0.15%	85.66%	3.79%	23.21%	0.01%	72.99%	1.58%	20.34%	0.00%	78.07%
III	6.30%	14.33%	0.02%	79.34%	5.65%	10.72%	0.00%	83.63%	5.81%	20.30%	0.02%	73.87%	3.36%	16.94%	0.00%	79.69%
IV	0.30%	58.22%	0.03%	41.45%	1.61%	63.40%	0.00%	35.00%	0.71%	56.50%	0.02%	42.77%	0.86%	63.44%	0.00%	35.70%
V	0.09%	66.25%	0.00%	33.65%	0.96%	73.97%	0.04%	25.03%	0.48%	59.39%	0.01%	40.11%	0.46%	67.88%	0.00%	31.66%
VI	0.30%	58.23%	0.01%	41.46%	1.34%	63.27%	0.00%	35.38%	0.79%	55.67%	0.02%	43.52%	1.33%	62.15%	0.00%	36.51%

	MNL- BCML				ML- BCML				BCL- BCML			
	Prob. Alg	Prob. Bar	Prob. Bil	Prob. Val	Prob. Alg	Prob. Bar	Prob. Bil	Prob. Val	Prob. Alg	Prob. Bar	Prob. Bil	Prob. Val
I	3%	-3%	0%	0%	3%	-7%	0%	4%	2%	4%	0%	-6%
II	1%	-1%	0%	0%	0%	-8%	0%	8%	2%	3%	0%	-5%
III	3%	-3%	0%	0%	2%	-6%	0%	4%	2%	3%	0%	-6%
IV	-1%	-5%	0%	6%	1%	0%	0%	-1%	0%	-7%	0%	7%
V	0%	-2%	0%	2%	1%	6%	0%	-7%	0%	-8%	0%	8%
VI	-1%	-4%	0%	5%	0%	1%	0%	-1%	-1%	-6%	0%	7%

I Madrid - EE.UU
II Madrid - China
III Madrid - Brasil
IV Zaragoza - EE.UU
V Zaragoza - China
VI Zaragoza - Brasil

- BCML *versus* MNL, ML y BCL $\Rightarrow$ Prob. +/- 8%.

Scenario (A) analysis

Shipment†	MNL Prob. Alg	MNL Prob. Bar	MNL Prob. Bil	MNL Prob. Val	ML Prob. Alg	ML Prob. Bar	ML Prob. Bil	ML Prob. Val	BCL Prob. Alg	BCL Prob. Bar	BCL Prob. Bil	BCL Prob. Val	BCML Prob. Alg	BCML Prob. Bar	BCML Prob. Bil	BCML Prob. Val
I	11.18%	25.41%	0.06%	63.35%	9.06%	19.46%	0.00%	71.48%	7.55%	29.81%	0.04%	62.60%	4.13%	24.36%	0.00%	71.50%
II	4.13%	34.49%	0.01%	61.37%	2.34%	23.19%	0.10%	74.37%	5.37%	32.92%	0.02%	61.69%	2.07%	28.29%	0.00%	69.65%
III	11.18%	25.41%	0.04%	63.37%	9.87%	19.39%	0.00%	70.74%	8.28%	28.93%	0.03%	62.76%	4.79%	23.79%	0.00%	71.42%
IV	0.38%	75.40%	0.03%	24.18%	3.03%	78.74%	0.00%	18.23%	0.86%	68.30%	0.02%	30.81%	1.15%	73.93%	0.00%	24.91%
V	0.11%	81.29%	0.00%	18.60%	0.49%	87.79%	0.15%	11.58%	0.58%	70.88%	0.01%	28.53%	0.51%	77.82%	0.00%	21.67%
VI	0.38%	75.41%	0.02%	24.18%	2.74%	78.72%	0.00%	18.55%	0.96%	67.55%	0.02%	31.47%	1.27%	73.02%	0.00%	25.71%

	MNL- BCML Prob. Alg	MNL- BCML Prob. Bar	MNL- BCML Prob. Bil	MNL- BCML Prob. Val	ML- BCML Prob. Alg	ML- BCML Prob. Bar	ML- BCML Prob. Bil	ML- BCML Prob. Val	BCL- BCML Prob. Alg	BCL- BCML Prob. Bar	BCL- BCML Prob. Bil	BCL- BCML Prob. Val
I	7%	1%	0%	-8%	5%	-5%	0%	0%	3%	5%	0%	-9%
II	2%	6%	0%	-8%	0%	-5%	0%	5%	3%	5%	0%	-8%
III	6%	2%	0%	-8%	5%	-4%	0%	-1%	3%	5%	0%	-9%
IV	-1%	1%	0%	-1%	2%	5%	0%	-7%	0%	-6%	0%	6%
V	0%	3%	0%	-3%	0%	10%	0%	-10%	0%	-7%	0%	7%
VI	-1%	2%	0%	-2%	1%	6%	0%	-7%	0%	-5%	0%	6%

I Madrid - EE.UU
II Madrid - China
III Madrid - Brasil
IV Zaragoza - EE.UU
V Zaragoza - China
VI Zaragoza - Brasil

- ↑ of the degree of use of the facilities of the port of Valencia.
- TC oves from class C to class D
  (greater impact of congestion effects).
- The probability of choosing Valencia port decreases in favor of the other alternatives.
- BCML *versus* MNL, ML y BCL ⇒ Prob. +/- 10%.

Scenario (B) analysis

Shipment†	MNL Prob. Alg	MNL Prob. Bar	MNL Prob. Bil	MNL Prob. Val	ML Prob. Alg	ML Prob. Bar	ML Prob. Bil	ML Prob. Val	BCL Prob. Alg	BCL Prob. Bar	BCL Prob. Bil	BCL Prob. Val	BCML Prob. Alg	BCML Prob. Bar	BCML Prob. Bil	BCML Prob. Val
I	9.22%	20.96%	0.05%	69.77%	8.88%	18.08%	0.00%	73.05%	7.66%	30.23%	0.04%	62.07%	5.64%	34.50%	0.00%	59.86%
II	3.42%	28.61%	0.01%	67.96%	2.66%	21.42%	0.04%	75.88%	5.45%	33.38%	0.02%	61.15%	3.01%	39.24%	0.00%	57.76%
III	9.22%	20.96%	0.03%	69.79%	9.34%	17.07%	0.00%	73.59%	8.39%	29.35%	0.03%	62.23%	6.67%	33.24%	0.00%	60.10%
IV	0.36%	69.75%	0.03%	29.86%	2.89%	77.50%	0.00%	19.61%	0.87%	68.78%	0.02%	30.33%	1.15%	83.44%	0.00%	15.40%
V	0.11%	76.52%	0.00%	23.37%	0.82%	86.61%	0.09%	12.48%	0.58%	71.34%	0.01%	28.07%	0.83%	86.03%	0.00%	13.15%
VI	0.36%	69.76%	0.02%	29.86%	1.95%	78.13%	0.00%	19.93%	0.97%	68.03%	0.02%	30.98%	1.44%	82.67%	0.00%	15.89%

	MNL- BCML Prob. Alg	MNL- BCML Prob. Bar	MNL- BCML Prob. Bil	MNL- BCML Prob. Val	ML- BCML Prob. Alg	ML- BCML Prob. Bar	ML- BCML Prob. Bil	ML- BCML Prob. Val	BCL- BCML Prob. Alg	BCL- BCML Prob. Bar	BCL- BCML Prob. Bil	BCL- BCML Prob. Val
I	4%	-14%	0%	10%	3%	-16%	0%	13%	2%	-4%	0%	2%
II	0%	-11%	0%	10%	0%	-18%	0%	18%	2%	-6%	0%	3%
III	3%	-12%	0%	10%	3%	-16%	0%	13%	2%	-4%	0%	2%
IV	-1%	-14%	0%	14%	2%	-6%	0%	4%	0%	-15%	0%	15%
V	-1%	-10%	0%	10%	0%	1%	0%	-1%	0%	-15%	0%	15%
VI	-1%	-13%	0%	14%	1%	-5%	0%	4%	0%	-15%	0%	15%

I Madrid - EE.UU
II Madrid - China
III Madrid - Brasil
IV Zaragoza - EE.UU
V Zaragoza - China
VI Zaragoza - Brasil

- $\downarrow$ of the degree of use of the facilities of the port of Valencia.
- TC moves from class C to class A (less impact of economies of agglomeration, scale or network effects).
- The probability of choosing Valencia port decreases in favor of the other alternatives. (*more sharply than in scenario (A)*).
- BCML *versus* MNL, ML y BCL $\Rightarrow$ Prob. +/- 18%.

Outline

Conclusions

- For the case study we have found a significant presence:
  - Heterogeneity in preferences.
  - Nonlinear influence of the variables.
- It has been established that disregarding these circumstances entails important differences in predictions.
- The applied methodology allows to estimate models that collect heterogeneity in preferences in spite of not having data of the decision makers.

Martinez-Pardo, A., Orro, A. & Garcia-Alonso, L. (2017). Modelling Port choice allowing heterogeneous preferences and nonlinearity in variables. Manuscript in progress

Work in progress

- Test others indicators for degree of use of port facilities (TC). For example, other port performance indicators relate to the berth (TEU per metre of quay) or the yard (TEU per hectare).
- Update complement the research database with surveys.
- Extend to other geographical areas or ports (new database?).

More ideas? Do you want to collaborate?

GOAPORT: Go ahead port!

Modelling Port choice: analysis of shipments from the hinterland of the Spanish ports

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