

# The Ausubel auction in the EU ETS

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## The motivation...

- Global warming and GHG emissions are *the* problems of the century
- The innovative character of emission permits market (EPM) as a policy instrument to fight a global negative externality
- EU ETS is one of the biggest environmental policy experiments ever

## The motivation...

- Grandfathering was the chosen rule for emission permits initial allocation on the 1<sup>st</sup> and 2<sup>nd</sup> phases of the EU ETS.
- However, AUCTIONING is the allocation method recommended for the next phases (COM(2008) 16 final, 23.1.2008)

## The motivation...

“Auctioning best ensures efficiency of the ETS, transparency and simplicity of the system and avoids undesirable distributional effects.

Auctioning also best complies with the polluter-pays principle and rewards early action to reduce emissions. For these reasons auctioning should be the basic principle for allocation.”

(COM(2008) 16 final, 23.1.2008, p.7)

# Objective

To experimentally test the performance of an institution that parallels EU ETS but including auction as a rule for the initial allocation of (100%) CO<sub>2</sub> emission permits.

# Outline

- Introduction
- Experimental Design
- Benchmarks
- Results
- Conclusion

# Introduction

- Several experimental studies exist on EPM: Godby *et al.* (1997), Cronshaw and Brown-Kruse (1999a), Franciosi *et al.* (1999), Cason *et al.* (1999), Mestelman *et al.* (1999) and Gangadharan *et al.* (2005) are just a few.
- Laboratory experiments on American and Canadian markets for SO<sub>2</sub> were used to test the rules chosen.

# Introduction

- Benz and Ehrhart (2007) experimental study on EU ETS, for instance, is far from being an EU ETS testbedding.
- The main contribution of our work is to include both the rules and the parameters that parallels the EU ETS structure (and test a specific auction type).



# Introduction

## An auction type had to be chosen...

- Unique price auctions for multiple units are inefficient as result on demand reduction (ex: Holt (2006); Ausubel e Cramton (1998)).
- Vickrey (1961) static auction and Ausubel (2004) dynamic equivalent version are efficient auctions for multiple units.

# Introduction

- Kagel and Levin (2001), Engelmann and Grimm (2004) and Manelli *et al.* (2006), for example, experimentally test the Ausubel auction.
- However, their laboratorial environment is far from resembling EU ETS or any EPM.

# Introduction

- Holt *et al.* (2007) experimental study represent several characteristics of EPM and test the performance of 5 different auction institutions for CO<sub>2</sub> allocation (unique and discriminative static auctions; English auction; Dutch auction and anglo-dutch auction).
- But DO NOT test the performance of the Ausubel auction.

# Experimental Design

Each computerized (zTree) experimental session constituted by 3 parts:

1. Socioeconomic questionnaire
2. Multiple Price List (Holt and Laury, 2002) - elicitation of risk aversion attitudes
3. **EMISSION PERMITS MARKET**

Decisão	Forma A	Forma B
1	<input type="checkbox"/> Se bola 1 recebe 2.00 Euros    Se bola 2 a 10 recebe 1.60 Euros	<input type="checkbox"/> Se bola 1 recebe 3.85 Euros    Se bola 2 a 10 recebe 0.10 Euros
2	<input type="checkbox"/> Se bola 1 a 2 recebe 2.00 Euros    Se bola 3 a 10 recebe 1.60 Euros	<input type="checkbox"/> Se bola 1 a 2 recebe 3.85 Euros    Se bola 3 a 10 recebe 0.10 Euros
3	<input type="checkbox"/> Se bola 1 a 3 recebe 2.00 Euros    Se bola 4 a 10 recebe 1.60 Euros	<input type="checkbox"/> Se bola 1 a 3 recebe 3.85 Euros    Se bola 4 a 10 recebe 0.10 Euros
4	<input type="checkbox"/> Se bola 1 a 4 recebe 2.00 Euros    Se bola 5 a 10 recebe 1.60 Euros	<input type="checkbox"/> Se bola 1 a 4 recebe 3.85 Euros    Se bola 5 a 10 recebe 0.10 Euros
5	<input type="checkbox"/> Se bola 1 a 5 recebe 2.00 Euros    Se bola 6 a 10 recebe 1.60 Euros	<input type="checkbox"/> Se bola 1 a 5 recebe 3.85 Euros    Se bola 6 a 10 recebe 0.10 Euros
6	<input type="checkbox"/> Se bola 1 a 6 recebe 2.00 Euros    Se bola 7 a 10 recebe 1.60 Euros	<input type="checkbox"/> Se bola 1 a 6 recebe 3.85 Euros    Se bola 7 a 10 recebe 0.10 Euros
7	<input type="checkbox"/> Se bola 1 a 7 recebe 2.00 Euros    Se bola 8 a 10 recebe 1.60 Euros	<input type="checkbox"/> Se bola 1 a 7 recebe 3.85 Euros    Se bola 8 a 10 recebe 0.10 Euros
8	<input type="checkbox"/> Se bola 1 a 8 recebe 2.00 Euros    Se bola 9 a 10 recebe 1.60 Euros	<input type="checkbox"/> Se bola 1 a 8 recebe 3.85 Euros    Se bola 9 a 10 recebe 0.10 Euros
9	<input type="checkbox"/> Se bola 1 a 9 recebe 2.00 Euros    Se bola 10 recebe 1.60 Euros	<input type="checkbox"/> Se bola 1 a 9 recebe 3.85 Euros    Se bola 10 recebe 0.10 Euros
10	<input type="checkbox"/> Se bola 1 a 10 recebe 2.00 Euros	<input type="checkbox"/> Se bola 1 a 10 recebe 3.85 Euros

# Experimental Design (EMISSION PERMITS MARKET)

Laboratory rules respected the European Commission choices for the EU ETS implicit at the 2003/87/EC Directive:

- cap-and-trade system
- banking
- double auction with discriminative prices (reflecting rules of exchanges)
- penalty structure for incompliance

# Experimental Design (EMISSION PERMITS MARKET)

Instead of the 2003/87/EC Directive initial allocation rule for CO<sub>2</sub> emission permits (grandfathering) we followed the COM(2008)16final recommendation:

- to use auctioning as “the basic principle for allocation.”

# Experimental Design

Also included uncertainty on effective emissions abatement level.

Random variation on emissions drawn from a uniform distribution  $(-1, 0, +1)$  – as Godby *et al.* (1997).

To assure comparability of results we used the same uniform distribution for the different experimental sessions.



# Experimental Design

**PARAMETERS** chosen for the market intended to parallel EU ETS.

- Marginal abatement costs structure based on Eyckmans *et al.* (2000)
- Participants' dimension proportional to Belgium (S1), Spain (S2), Germany (S3), Greece (S4), France (S5), Italy (S6), United Kingdom (S7) and Netherlands (S8).
- Emissions targets fixed according to EU Burden Sharing Agreement (BSA).

# Experimental Design

## PARAMETERS:

- Emission permits supply fixed (at the auction) for each of the 10 periods of the session (88 units)
- Penalty for noncompliance: -560 points and one permit less on the period following the infraction.

# Experimental Design

**Imperfect competition** characterised our laboratorial market: participants with heterogeneous dimensions, marginal abatement costs and emission targets (under imperfect information about effective emission levels – uncertainty context on the demand side).

# Experimental Design

Neutral language on Instructions :

emission permits, environmental goals or policy instruments for regulation were never mentioned: an homogeneous good produced at different scales and costs that could be traded in a certain market...

# Experimental Design

Stages of the third part of our experiments  
(repeated in the 10 periods of our 4 sessions )

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**Stage 1:** *Auction participation*

**Stage 2:** *Banking decision*

**Stage 3:** *Permit market participation*

**Stage 4:** *Information about random shock*

**Stage 5:** *Reconciliation market participation*

**Stage 6:** *Re-banking.*

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# Stage 1: Auction

Período

1 em 3

Tempo Restante [sec]: 302

UNIDADES	CUSTO
1	40
2	60
3	110
4	180
5	260
6	350
7	450

Preço = 130

Tem 4 unidades lucrativas a este preço.

Recorde que o seu ganho em cada unidade é CUSTO-PREÇO

Número de unidades que pretendo comprar a este preço

Quantidade

OK

# Stage 1: Auction

Período

1 em 3

Tempo Restante [sec]: 53

UNIDADES	CUSTO	ADQUIRIDA
1	40	
2	60	
3	110	
4	180	
5	260	SIM
6	350	SIM
7	450	SIM

O seu ganho total no leilão é de 490 pontos.

Adquiriu um total de 3 unidades aos seguintes preços:

QUANTIDADES	PREÇOS
0	130
0	160
3	190

OK

# Stage 2: Banking

Período

1 em 3

Tempo Restante [sec]: 594

UNIDADES	CUSTO	ADQUIRIDA
1	40	
2	60	
3	110	
4	180	
5	260	SIM
6	350	SIM
7	450	SIM

## PLANO DE UTILIZAÇÃO DAS UNIDADES ADQUIRIDAS

Período	1	2	3	4	5	6	7	8	9	10	TOTAL
Adquiridas	3	0	0	0	0	0	0	0	0	0	3
Uso planeado	<input type="text" value="3"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	0

CLIQUE OK PARA CALCULAR O TOTAL DAS UNIDADES ADQUIRIDAS.

TOTAL

OK para avançar

Lucro neste período= 490  
Lucro acumulado até agora= 0



# Stage 3: Permits Market

Período

1 em 3

Tempo Restante [sec]: 17

UNIDADES	CUSTO	ADQUIRIDA	LUCROS
1	40		0
2	60		0
3	110		0
4	180		0
5	260	SIM	0
6	350	SIM	0
7	450	SIM	0

Preço  
COMPRA

OK

Preço  
VENDA

OK

Compra-se ao preço de

VENDO

Vende-se ao preço de

COMPRO

Preços Transacções

Lucro neste período= 490  
Lucro acumulado até agora= 490

OK para fase seguinte

# Stage 4: Information about random shock

Periodo

1 em 3

Tempo Restante [sec]: 36

UNIDADES	CUSTO	ADQUIRIDA	LUCROS				
1	40		0	<p>Resolução da Incerteza</p> <hr/> <p>Variação nas Unidades detidas: 1</p> <hr/> <p>Detém mais uma unidade do que o previsto. Foi suportado desnecessariamente o custo da unidade número:</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td>5</td></tr> <tr><td> </td></tr> <tr><td> </td></tr> </table> <p>Pode, porém, tentar ainda vendê-la no mercado que abre de seguida ou então guardá-la para períodos futuros.</p> <p>Se <b>VENDER</b>, o seu ganho será de Preço de Venda - Custo dessa unidade.</p> <p>Se <b>GUARDAR</b>, os ganhos actuais diminuem no valor do seu custo mas num momento futuro aumentam pelo valor do custo que evitar então suportar.</p> <p>Se nada fizer, essa unidade terá um impacto negativo nos seus ganhos, correspondente ao valor do seu custo.</p> <hr/> <p>Impacto da Incerteza no Lucro= -260</p> <p>Lucro neste período= 350</p> <p>Lucro acumulado até agora= 350</p>	5		
5							
2	60		0				
3	110		0				
4	180		0				
5	260	SIM	-260				
6	350	SIM	0				
7	450	SIM	0				

# Stage 5: Reconciliation market

Periodo

1 em 3

Tempo Restante [sec]: 43

UNIDADES	CUSTO	ADQUIRIDA	LUCROS
1	40		0
2	60		0
3	110		0
4	180		0
5	260	A vender	-260
6	350	SIM	0
7	450	SIM	0

Preço  
COMPRA

OK

Preço  
VENDA

OK

Compra-se ao preço de

VENDO

Preços Transacções

Vende-se ao preço de

COMPRO

Lucro neste mercado= 0  
Lucro neste período= 350  
Lucro acumulado até agora= 350

OK para fase seguinte

# Stage 6: Rebanking

Período

1 em 3

Tempo Restante [sec]: 51

**Se preferir, pode guardar a unidade para o próximo período.**

**Quer guardar uma unidade agora?**

- SIM  
 NÃO

NOTA:

Se escolher NÃO, suporta o custo desta unidade, afectando assim os seus resultados de forma negativa.

Se escolher SIM, fica com mais uma unidade guardada para o próximo período.

*Depois de assinalar a sua escolha, clique em OK para continuar.*

OK

OK para avançar

Lucro neste período= 350

Lucro acumulado até agora= 350

# Benchmarks

Supply and demand conditions are **NOT** the same on the 10 periods of the sessions, although marginal abatement costs and participants' dimensions are fixed, as well as the supply in each period (88).

# Benchmarks

**Random fluctuations** on emissions, the **penalty** imposed and the possibility of **banking** change supply and demand conditions on the 10 periods.

# Benchmarks

*Ex-ante* determination of equilibrium price and quantity benchmarks' considered the **uncertainty matrix** resultant from the uniform distribution used for all sessions.

# Benchmarks

Following Godby *et al.* (1997) we determined all benchmarks considering two cases:

- 1) Use of all permits bought in the auction for the period - *System Optimum Benchmarks*;
- 2) Retention (banking) of one permit in each period, for precautionary reasons - Market Equilibrium Benchmarks .



# Results

- 4 sessions run on the 12<sup>th</sup> , 18<sup>th</sup> , 19<sup>th</sup> and 20<sup>th</sup> of May 2009 at Minho University – Braga, Portugal (after a pilot session on the 21<sup>st</sup> of March 2009).
- €22.15 average earnings on the 4 sessions (including a 5€ participation fee).

## Results

- Risk neutral or risk averse subjects did not bank one unit each period (0.65 units on average).
- Excessive banking in one of the sessions resulted in excess supply at the first price of the auction (therefore, more restrictive abatement target).

## Results

- Significant differences between our auction permits allocation and the Ausubel auction predictions (abatement costs statistically different from benchmarks)
- Secondary market efficiently reallocated emission permits (realized gains superior to potential ones).

# Efficiency Index

Period	Session 5		Session 6		Session 7		Session 8		TOTAL		TOT_ses5	
	Is <sub>5</sub>	Im <sub>5</sub>	Is <sub>6</sub>	Im <sub>6</sub>	Is <sub>7</sub>	Im <sub>7</sub>	Is <sub>8</sub>	Im <sub>8</sub>	Is	Im	Is	Im
1	-8.74	-3.16	-0.89	1.14	-0.50	1.36	-3.35	-0.21	-3.37	-0.22	-1.58	0.76
2	-2.42	-2.42	1.24	1.24	0.78	0.78	1.02	1.02	0.16	0.16	1.02	1.02
3	-0.23	-0.23	0.56	0.56	0.99	0.99	1.31	1.31	0.66	0.66	0.95	0.95
4	1.19	1.19	1.10	1.10	0.86	0.86	0.81	0.81	0.99	0.99	0.92	0.92
5	1.73	1.73	1.28	1.28	1.12	1.12	1.45	1.45	1.40	1.40	1.28	1.28
6	-1.87	-1.87	1.21	1.21	0.57	0.57	0.92	0.92	0.21	0.21	0.90	0.90
7	-0.72	-0.72	0.75	0.75	1.01	1.01	0.56	0.56	0.40	0.40	0.77	0.77
8	1.74	1.74	0.63	0.63	1.02	1.02	1.12	1.12	1.13	1.13	0.93	0.93
9	-0.91	-0.91	0.85	0.85	1.28	1.28	1.02	1.02	0.56	0.56	1.05	1.05
10	3.01	1.66	2.34	1.15	2.10	0.97	1.99	0.88	2.36	1.17	2.14	1.00
Average	-0.72	-0.30	0.91	0.99	0.92	1.00	0.68	0.89	0.45	0.64	<b>0.84</b>	<b>0.96</b>

# Conclusion

- The institution represented was efficient (excluding outlier – session 5) - the market worked.
- The Ausubel (2004) auction was not efficient when implemented in a more complex environment.
- Excessive banking results in more restrictive environmental targets and higher abatement costs, when auctioning is the initial allocation rule (not possible in the grandfathering treatment).

Thank you for your attention!

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# Results

Efficiency Index:

$$Is_i = \frac{(CCU_s - CostAbat_i)}{(CCU_s - BTU_s)} \quad , i = 5, 6, 7, 8$$

$$Im_i = \frac{(CCU_m - CostAbat_i)}{(CCU_m - BTU_m)} \quad , i = 5, 6, 7, 8$$