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**EUROPEAN UNION'S CO₂ EMISSION PERMITS MARKET – AN
EXPERIMENTAL STUDY**

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EXTENDED ABSTRACT

Global warming is a major issue on international political agendas regardless of the uncertainties and divergences still remaining on the real dimension of the problem. Scientific community disagreement on its true consequences for human life is even bigger but public opinion urges for action. Anthropogenic greenhouse gases (GHG) emissions became the target and its mitigation compulsory, as they are pointed as key responsible for the sudden and severe global climate change we are facing. Therefore, to choose the best policy instrument to achieve this environmental goal while minimizing the consequences for economies competitiveness is a crucial task.

A huge literature exists on the centralized versus market-based environmental policy instruments debate. Just as well documented and discussed is the particular case of GHG reductions. Economists elected market based instruments as the best also for environmental problems a long time ago. Interestingly, among those, political option to deal with global warming has been the use of tradable emission permits although economic literature points environmental taxes as the most appropriate to deal with GHG emissions when environmental costs and benefits of abatement are uncertain. Kyoto Protocol mechanisms or the European Union Emissions Trading Scheme (EU ETS) illustrate the political choice. Jacoby and Ellerman (2004) or Aldy *et al.* (2003),

for example, justify why economists' recommendation is on emissions taxes. Our work contribution is not, however, on the debate about this divergence between economists and politician choices. Abstracting from the emissions damages uncertainty (or, emissions abatement benefits) our key objective is to examine the functioning of the carbon emission permits markets with cost abatement uncertainty and several other real world implementation characteristics. A comprehensive description and analysis of this particular market mechanism allows us to fulfil one of the economists' main responsibilities: to provide policy recommendations. As mentioned by Binmore e Klemperer (2002, pg. C95) "Our marginal product in preventing mistakes can therefore sometimes be surprisingly large".

The innovative character of emission permits market as a policy instrument to fight a global negative externality justifies our investigation. To be the most efficient environmental policy instrument, as formally proved by Montgomery (1972), this should be a "perfect" market. As reality has all characteristics but perfection doubts arise on the effective achievements that will be possible with the creation of these markets. This is where our paper intends to contribute: to increase knowledge about the real performance of emission permits markets for GHG. More specifically, we focus on the EU ETS and its institutional characteristics. EU ETS is one of the biggest environmental policy experiments ever. Its dimension, multi- jurisdictional political structure, connection between differing domestic emissions permits programs and innovative character on dealing with greenhouse gases emissions on a big scale justify its status. According to the World Bank Report by Capoor and Ambrosi (2008), in 2007 the EU ETS was still the major carbon market, by far, both on volume and value. Therefore, enormous attention is currently placed on its performance and developments by those who plan to implement a similar policy.

We decided to use the experimental methodology to pursue our goal. As pointed by Smith (1982), it is not possible to design a laboratory experiment about resources allocation without rigorously defining all the institutional rules and details. Although not formalized at the theoretical model describing emission permits markets these are characteristics that matter for its final results. Plott and Smith (1978) concluded "institutions do matter" and we considered laboratory experiments to be the most appropriate methodology to evaluate its importance on the emission permits market case.

Our experimental design intended to include as many EU ETS characteristics as possible without rendering the experiment too complex. Previously to the implementation of any emission permits market, laboratorial included, decisions must be made on its market rules:

- i) whether to allow emission permits intertemporal usage (*banking* current permits for future use and/ or *borrowing* permits for future periods and use them at present);
- ii) emission reductions basis definition (absolute reference –*cap-and-trade* system – or relative reference – *baseline-and-credit* system);
- iii) the initial allocation method (free allocation - grandfathering – or auctioning);
- iv) transaction rules between firms (bilateral transactions, double auctions, or others);
- v) equilibrium price rule (unique price, discriminative price, first rejected or last accepted price).

On what concerns the rules pointed above, our experimental design respected the European Commission choices for the EU ETS implicit at the 2003/87/EC Directive: a cap-and-trade system with grandfathering of emission permits and banking but not borrowing. Although over-the-counter transactions of CO₂ emission permits represented a great share on the EU ETS, our experimental design reflects the functioning and transactions made on the exchanges: double auction with discriminative prices.

Laboratory experiments to study emission permits markets were used by 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), just to name a few. Therefore, our experiments may be considered a development on those that already exist about this policy instrument. However, if American or Canadian markets were considered by many, the European case has still a long way to go. Benz and Ehrhart (2007) experimental study on EU ETS, for instance, is far from being an EU ETS testbedding. To our knowledge, the present work is the first experiment to include both the rules and the parameters that parallels the EU ETS structure. Marginal abatement costs, participants dimension and its environmental targets were defined to accomplish that. In addition, a penalty structure for incompliance, similar to the one prescribed at

the 2003/87/EC Directive, was introduced in our experimental treatments: a monetary penalty and the obligation to reduce, on the subsequent period, the excess emissions.

Eyckmans *et al.* (2000) study was used to determine our marginal abatement costs structure and each participant's abatement target has a relation with EU ETS agents. To assure laboratorial feasibility and respect budget restrictions we represented a proportional but small dimension market. Each experimental session included eight subjects representing one country of the EU-15: Germany, Belgium, Spain, France, Greece, Netherlands, Italy and the United Kingdom. This selection was due to the fact of being the most pollutant countries of EU-15 and those who received a greater share of CO₂ emission permits. Its total emissions for the experiments were determined proportionally to the projections of those countries total emissions for 2010. CO₂ emission permits initial allocation was made accordingly to the EU Burden Sharing Agreement (BSA). Consequently, emission targets were more restrictive to some participants than others.

The market represented was, therefore, characterised by imperfect competition: heterogeneous dimensions, marginal abatement costs and emission targets. Additionally, our experimental design included uncertainty on effective emission levels (or abatement), which means market agents do not have perfect information when deciding how to respect the environmental restriction they face and minimizing costs. Following Godby *et al.* (1997) procedures, we considered a random variation on emissions with values drawn from a uniform distribution (-1, 0, +1). To assure comparability of results we used the same uniform distribution for the different experimental sessions. This kind of uncertainty usually implies a high volatility on emission trading prices and the possibility of banking is one of the preferred solutions to the problem. Therefore, inclusion of this characteristic on our experimental treatments not only parallels EU ETS but also allows testing once again a theoretical solution usually recommended on these cases.

Another innovation of our experimental design it was the use of a multiple price list (MPL) to induce subjects preferences over risk at the beginning of each session, similar to Holt and Laury (2002). Before participating at the laboratory market subjects were asked to take ten decisions about two forms of payment with different prizes. The objective was to compare the results of the individual choices on this part of the experimental session with their behaviour at the emission permits market (banking, or not, as a precautionary strategy).

To conduct computerized sessions, the experiments were programmed using zTree software (Zurich Toolbox for Readymade Economic Experiments, Fischbacher, (1999)). A pilot session was run in March 2008 and the four sessions effectively paid run with undergraduate students from Minho University (Braga, Portugal) on the two first weeks of November 2008. Recruitment was done through advertising on University campus and 32 students participated on the experiments: 4 sessions with 8 students each. Sessions took about two hours and a half, including reading of instructions, training and effective decision making. Students earnings ranged from 5,1€ to 28,34€, with an average payment of 15,83€ per student in the 4 sessions. This payments included a 5€ participation fee plus earnings related with the choice of payment form in the second part of the experiment (between 0,1€ and 3,85€) and earnings from the third part of the experiment – the emission permits market. These were calculated transforming the points made there at a conversion rate of 100 points = 1€.

From the analysis of the experimental data collected with the MPL we classify the great majority of our participants averse to risk (a bigger percentage than the one reported by Holt and Laury (2002, 2005) or Harrison *et al.* (2005)). However, this classification does not result in a precautionary behavior at the emission permits market through retention of one title along all the experimental sessions.

Prices on the 10 periods of each of the four sessions were generally above the benchmark prices and the opposite occurred with quantities. Consequently, total abatement costs were slightly above the minimum abatement costs but were clearly below the command-and-control reference. This means the laboratorial market implemented worked and total emission abatement costs were reduced in comparison with initial allocation. Even with a complex environment, that we tried to be similar to the EU ETS, these experimental sessions enlarge the arguments favoring the efficiency of emission permits markets.

This was the first step of our investigation. We are now preparing to run other experimental sessions for a treatment with only one difference when comparing to those just presented: the initial allocation method. Instead of grandfathering the emission permits we are going to run an auction at the beginning of each period. The European Commission and its Member-States are currently discussing the use of auctioning as a rule for the initial allocation method in the next stages of the EU ETS. We hope to contribute to that discussion with the results of our next experiments.

Keywords: EU ETS; experimental markets; grandfathering; banking; uncertainty.

JEL Classification: C90; C99; Q59.

REFERENCES:

Aldy, Joseph E.; Barret, Scott; Stavins, Robert N. (2003), “Thirteen plus one: a comparison of global climate policy architectures”, *Climate Policy* 3, pgs. 373-397

Benz, Eva; Ehrhart, Karl-Martin (2007), “The Initial Allocation of CO₂ Emission Allowances: A Theoretical and Experimental Study”, Working Paper.

Binmore, Ken; Klemperer, Paul (2002), “The biggest auction ever: the sale of the British 3G Telecom licences”, *The Economic Journal*, 112 (March), pgs. C74-C96.

Capoor, Karan; Ambrosi, Philippe (2008), “State and Trends of the Carbon Market 2008”, *International Emissions Trading Association*, The World Bank, Washington DC, May 2008.

Cason, Timothy N.; Elliot, Steven R.; Van Boening, Mark R. (1999), “Speculation in experimental markets for emission permits”, *Research in Experimental Economics*, Volume 7, (1999) R. M. Isaac and C. Holt (eds.), Stamford, Conn.: JAI Press, pgs. 93-119

Cronshaw, M. B.; Brown-Kruse, J. (1999), “An experimental analysis of emission permits with banking and the Clean Air Act Amendments of 1990”, *Research in Experimental Economics*, Volume 7, (1999) R. M. Isaac and C. Holt (eds.), Stamford, Conn.: JAI Press, pgs. 1-24

European Commission (2003), “Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC” *Official Journal of the European Union*, L 275/32, 25.10.2003

Eyckmans, Johan; Cornillie, Jan; Van Regemorter, Denise (2000), "Efficiency and Equity in the EU Burden Sharing Agreement", CES Katholieke Universiteit Leuven, Working Paper 2000-02, Revised June 2002

Fischbacher, Urs (1999), "z-Tree. Toolbox for Readymade Economic Experiments", IEW Working paper 21, University of Zurich

Franciosi, R.; Isaac, R. Mark; Reynolds, Stanley S. (1999), "Experimental research on the EPA's "two-tier" system for marketable emissions permits", *Research in Experimental Economics*, Volume 7, (1999) R. M. Isaac and C. Holt (eds.), Stamford, Conn.: JAI Press, pgs. 25-44.

Gangadharan, Lata; Farrel, Alex; Croson, Rachel (2005), "Investment Decisions and Emissions Reductions: Results from Experiments in Emissions Trading", University of Melbourne, Department of Economics, Research Paper No. 942.

Godby, Robert William; Mestelman, Stuart; Muller, R. Andrew; Welland, J. Douglas (1997), "Emissions Trading with Shares and Coupons when Control over Discharges is Uncertain", *Journal of Environmental Economics and Management* 32, (2), pgs. 359-381.

Harrison, Glenn W.; Johnson, Eric; McInnes, Melayne M.; Rutström, E. Elisabet (2005), "Risk Aversion and Incentive Effects: Comment", *The American Economic Review*, Vol. 95, No.3, pgs. 897–901.

Holt, Charles; Laury, Susan K. (2002), "Risk Aversion and Incentive Effects", *The American Economic Review*, Vol. 92, No.5, pgs. 1644–1655.

Holt, Charles; Laury, Susan K. (2005), “Risk Aversion and Incentive Effects: New Data without Order Effects”, *The American Economic Review*, Vol. 95, No.3, pgs. 902–904.

Jacoby, Henry D.; Ellerman, A. Denny (2004), “The safety valve and climate policy”, *Energy Policy* 32 (4), pgs. 481-491

Mestelman, S.; Moir, Rob; Muller, R.A (1999), “A laboratory test of a Canadian proposal for an emissions trading program”, in *Research in Experimental Economics* 7, (Emissions Permit Experiments) Charles A. Holt and R.Mark Isaac (editors). Greenwich, Connecticut: JAI Press, pgs. 45-91

Montgomery, D. (1972), “Markets in Licenses and Efficient Pollution Control Programs”, *Journal of Economic Theory* 5, pgs. 395-418.

Plott, Charles R.; Smith, Vernon L. (1978), “An experimental examination of two exchange institutions”, *Review of Economic Studies* 45(1), pgs. 133-153.

Smith, Vernon L. (1982), “Microeconomic Systems as an Experimental Science”, *The American Economic Review*, pgs. 923-955.