1. ***Para alcanzar un determinado nivel agregado de emisiones minimizando los costos totales de un programa basado en estándares, un regulador que no puede observar los costos de abatimiento de las empresas, ¿debe diseñar el programa de forma de permitir cierto nivel de transgresiones o debe diseñarlo de tal forma que haya cumplimiento perfecto?***

**I.1. Full information on abatement costs**

We start by trying to answer the question in the case the regulator can observe the abatement costs of the firms.

In this case, the regulator has two possible penalty schemes: increasing or constant marginal penalties. We start by assuming the marginal penalty is increasing.

***Individual choices under increasing marginal penalty***

Penalty:

Given all the relevant parameters, a firm *i* solves the following problem:

The Lagrangean of this problem is:

And the Kuhn – Tucker conditions:

From these, we know that the firm complies with the standard 

If this is not the case, the firm violates the standard, in which case , and from KT condition 2), λ = 0 and

If we assume that (we give a functional form to ), then, the above conditions is:

From this expression we can get the firm´s reaction function:

Which gives the optimum violation () as a function of the abatement costs parameters, the enforcement parameters, and the level of the standard:

The regulator jointly determines and to induce the desired level of emissions (and violations) to minimize expected costs of achieving *E*. It can be seen from this equation that, contrary to the case of emissions permits (Stranlund, 2007), in this case there is a trade off for the regulator between the level of the emission standard it sets and the corresponding level of the probability of inspection it has to commit to in order to induce a certain level of violation for plant *i*.

***The regulatory choice of violations under increasing marginal penalty***

**General Characterization**

Where μ is the dollar cost of an inspection and β is the per dollar cost of collecting penalties.

Assuming positive standards and inspections probabilities, the necessary and sufficient conditions are given by:

From where

From where

Using (1)

From the firm’s optimal choice of emissions, we know that

From where,

**Given the assumption of increasing marginal penalty, this expression cannot be signed. The first term of the right hand side is negative and the second term**  **is positive. This means the the cost-effective levels of violations could be positive or zero.**

**Closed solution**

Assuming a penalty function of the form:

Which gives and increasing marginal penalty function of the form:

and

so

Carlos: llegué hasta aquí. La aparición de la probabilidad de monitoreo en la ecuación no me gusta, ya que estoy intentando llegar a una expresión de la violación minimizadora de costos que el regulador induce con su elección de la probabilidad y el estándar, pero sin hallar una expresión para estos dos. (No pude, son muchas cuentas, no probé con el scientific workplace que puede ser la solución). La seguimos en 10 días.

Substituting for and ,

And substituting for,

**Lagrange:**

**Condiciones de Kuhn Tucker**

Assuming ,

From (1)

From (2)