

# Optimal Regulation for Production with Multiple Externalities

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## ■ A SKETCH

### Motivation

- There exists a positive technology spillover among pollution abatements.
- Policy outcomes of one regulation often complement or contradict those of other regulations. → A comprehensive and integrated approach is desirable.
- In practice, regulations may be sequential. → Inefficiencies may arise.

### In this paper, we

- Employed a simple 2 period game to explore the issue of optimal regulation for multiple production externalities,
  - 2 corrective tax rates represent levels of regulations
- Found the following:
  - Regulation level under à la carte and non-integrated approach (determines one in year 1 and the other in year 2) deviates from the optimal level.

# I. INTRODUCTION

□ Examples of sequentially added regulations

- *Power sector*: The Acid rain Act (to regulate SO<sub>x</sub> and NO<sub>x</sub>) → The Indoor-air quality Act (to regulate micro particles such as PM<sub>10</sub>) → The Framework Act on LCGG (to regulate GHGs)
- *Regulations on steel industries in Korea*:

	'70's	'80's	'90's	After 2000
Air pollution	77: Environment Conservation Act (63: Pollution Prevention Act) 77: Introduction of EIA 79: Setting-up Air Quality Standards (SO <sub>x</sub> )	83: Items added to Air Quality Standards	91: An item, Pb, is added to Air Quality Standards 97: Adopting Emission Charges	04: Managing PM <sub>10</sub> Concentration in Public Spaces 10/12: Introduction of the GHG and Energy Target Management System 12: Implementing RPS 15: Adopting the ETS
Controlled pollutants	Dust, Smoke, SO <sub>x</sub>	NO <sub>x</sub> , Smog, Acid rain, O <sub>3</sub>	Odor, VOC, Chlorinated organic compounds, GHGs(Dr+Indrt)	

Water pollution	77: Legislating the Environment Conservation Act (63: Pollution Prevention Act) 77: Water Quality Standards (Sea Area)	87: Setting-up Zonal Environmental Standards	90: Legislating the Water Quality and Aquatic Ecosystem Conservation Act 97: Enacting Emission Charges	- Modifying Emission Regulation Standards - Pollution Caps for Closed Marines
Controlled pollutants	Organic Materials, Suspended Solid	TCE, PCE, Nitrogen, Phosphorus		Trace Element

VOC: volatile organic components

TCE: Trichloroethylene (C<sub>2</sub>HCl<sub>3</sub>: insecticide, anesthetic)

PCE: Tetrachloroethylene (C<sub>2</sub>Cl<sub>4</sub>: insecticide)

Source: Steel Industry and Environmental Regulation (<http://www.kncpc.or.kr/main/main.asp>)

- Inclusion of both direct and indirect emissions
- Proposed greenizing energy tax reforms

□ Claims against Overlapped Regulation & Regulation Rigidity

*A Survey (KERI) in Korea (2015)*

- Excessive burdens associated with multiple layers of environmental regulation are the highest.

## Achieve smarter and better regulation

**Calibrate carefully between the merits of regulation and market based responses.**

Multiple layers of regulation increase costs and introduce rigidity into the design process, resulting in a loss of innovation and competitiveness globally.

**We call upon policymakers to partner in a structured, coordinated and ongoing dialogue platform to unlock the sector's contribution to EU needs.**

Understanding the differentiated condition of one of Europe's major manufacturing industries is of critical importance to achieving jobs, growth and competitiveness.

**When policy is needed for our products, ensure it is clear, consistent, enforceable, and based on the New Legislative Framework.**

In case of regulation, adhere as much as possible to the New Legislative Framework by establishing the essential requirements in regulation, and elaborating the details in harmonised standards.



□ EU: Smart regulation

- Smart regulation: ‘...identify excessive burdens, overlaps, gaps and inconsistencies...’

(Marianne Klingbeil, Better Regulation Director, EU Commission)

□ [EPA \(2011\)](#), *Improving Our Regulations: Final Plan for Periodic Retrospective Reviews of Existing Regulations*

- In response to President Obama's charge in [Executive Order 13563](#) for each federal agency to:

“develop...a...plan, consistent with law and its resources and regulatory priorities, under which the agency will periodically review its existing significant regulations to determine whether any such regulations should be modified, streamlined, expanded, or repealed so as to make the agency's regulatory program more effective or less burdensome in achieving the regulatory objectives.”

- EPA's Main concerns ~ Modernizing regulations, *“What should a 21st century regulatory program look like?”*
  
- EPA intends to seek ways to promote regulation effectiveness and burden reduction through the following broad initiatives (EPA, 2011):
  - Electronic reporting,
  - Improved transparency,
  - Innovative compliance approaches, and
  - **Systems approaches and integrated problem-solving.**

→ **Data-driven approach + An Idea of minimizing regulation costs** (be responsive to President's memorandum in 2011 “Administrative Flexibility, Lower Costs, and Better Results for State, Local, and Tribal Governments”) + **NPM**

- In this process, EPA recognizes that there is potential for regulatory overlap and contradiction between various jurisdictional requirements.
  
- Examples of EPA's examination:
  - Fuel economy labeling with the California Air Resources Control Board (CARB) and the Federal Trade Commission;
  - Vehicle greenhouse gas standards and fuel-economy standards in conjunction with the Department of Transportation (DOT) and CARB; and
  - Vehicle testing and compliance standards with CARB

## □ Related Literature

- Heine, Norregaard, and Parry (IMF, WP2012), “*Environmental Tax Reform: Principles from Theory and Practice to Date*”
  - Examining welfare outcomes from multiple regulations on one action: Motor fuel taxes (account for congestion and other externalities associated with vehicle use) & Mileage-based taxes (account for congestion) in Germany, Sweden, Turkey, and Vietnam
  - → No distortion if externalities associated with fuel consumption are orthogonal to externalities associated with heavy mileage
  
- Bento, Kaffine, Roth, and Zaragoza-Watkins (AEJournal:Economic Policy 2014), “*The Effects of Regulation in the Presence of Multiple Unpriced Externalities*”

- Policies to stimulate the demand for ultra-low-emission-vehicles (ULEVs) ~ Solo-hybrid drivers access to high occupancy vehicle (HOV) lanes on major freeways (in place in nine states of the USA)
  - Worsens congestion (unpriced externalities)
  - (Emission-like externalities ~~→~~ congestion)
- Literature supporting the comprehensive or integrated approach
  - Key and Kaplan (2007), Sneeringer (2010), Howard (2012), Aagaard (2014), Kuethe and Morehart (2012) ~ considers interactions and multiple externalities from one action
- We add an analytical explanation why a comprehensive or integrated approach and/or periodical review is desirable to make regulations efficient

## I. MODEL

### □ Multiple Production Externalities

- Output market:  $P=B-q$
- Cost function:  $cq$ .
- Amount of 2 pollutants:  $(e_a, e_b)=(\alpha q, \beta q)$
- The value of environmental damage for producing  $q$ :  $s_a e_a$ .
- Level of regulation represented by a corrective tax rate:  $t_a$
- Costs to reduce the amount of a pollutant by  $a$ :  $0.5ga^2$
- Reduction in the amount of the other pollutant when the amount of the one pollutant is reduced by  $a$ :  $\delta_b a$

□ An Integrated Regulation:

- Firm's problem:

$$\pi = (B - q)q - cq - \frac{1}{2}ga^2 - \frac{1}{2}hb^2 - t_a(\alpha q - a - \delta_a b) - t_b(\beta q - b - \delta_b a)$$

- Regulator's problem :

$$V = \pi(q^*, a^*, b^*) + t_a(\alpha q^* - a^* - \delta_a b^*) + t_b(\beta q^* - b^* - \delta_b a^*) - s_a e_a - s_b e_b$$

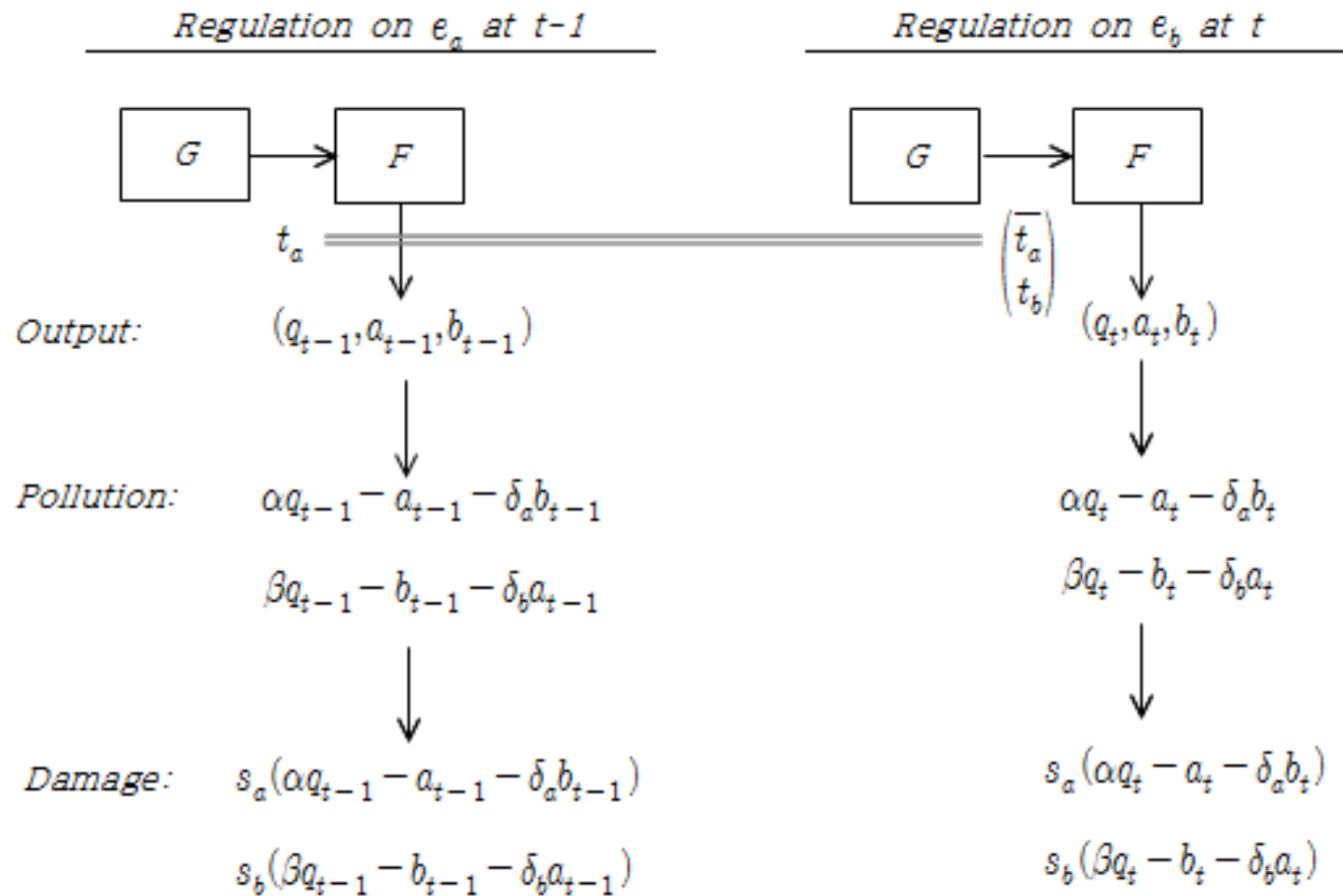
Note: 3 distortions in our model

- Externality distortion from pollutant 1
- Externality distortion from pollutant 2
- Imperfect market distortion (only one firm)

When CS is added,  $t_a = \delta_a - \frac{2k}{1+k^2} \delta_a < \delta_a$  [where,  $k = \frac{\alpha\beta gh + 2g\delta_a + 2h\delta_b}{\alpha^2 gh + 2g\delta_a^2 + 2h}$ ]

→ Government uses two policy instruments and targets to correct the first two distortions. **Or Krugman (1987, JEP)**

□ A Non-Integrated Approach:



● Firm's problem (the same)

● Regulator's problems :

$$V_{t-1} = \pi + t_a(\alpha q^* - a^* - \delta_a b^*) - s_a(\alpha q^* - a^* - \delta_a b^*) - \theta s_b(\beta q^* - b^* - \delta_b a^*)$$

$$V_t = \pi + \bar{t}_{a,t-1}(\alpha q^* - a^* - \delta_a b^*) + t_b(\beta q^* - b^* - \delta_b a^*) - \psi s_a(\alpha q^* - a^* - \delta_a b^*) \\ - s_b(\beta q^* - b^* - \delta_b a^*)$$

, where  $\theta, \psi \in [0,1]$

## II. Equilibrium Analysis

Table 2. Comparison between Integrated and Sequential Regulations

Category	Level of regulation
Regulation for the first pollutant ( $e_a$ )	
Integrated regulation	$t_a^o = s_a$
Sequential regulation	$t_{a,t-1}^o = s_a + \theta s_b \frac{\alpha\beta gh + 2g\delta_a + 2h\delta_b}{\alpha^2 gh + 2g\delta_a^2 + 2h}$
Comparison	$\theta=0 \rightarrow t_{a,t-1}^o = t_a^o$ $\theta > 0 \rightarrow t_{a,t-1}^o > t_a^o$
Regulation for the second pollutant ( $e_b$ )	
Integrated regulation	$t_b^o = s_b$

Sequential regulation	$t_{b,t}^o$ $= \left\{ 1 - \frac{\theta(\alpha\beta gh + 2g\delta_a + 2h\delta_b)^2}{(\alpha^2 gh + 2g\delta_a^2 + 2h)(\beta^2 gh + 2h\delta_b^2 + 2g)} \right\} s_b$ $- (\psi) \left\{ \frac{\alpha\beta gh + 2h\delta_b + 2g\delta_a}{\beta^2 gh + 2h\delta_b^2 + 2g} \right\} s_a$
Comparison	$\theta = 0 \text{ and } \psi = 1 \rightarrow t_{b,t}^o = t_b^o$ $\theta > 0 \text{ (regardless of } \psi) \rightarrow t_{b,t}^o < t_b^o$

- The earlier regulation in year 1 is higher than that of the integrated regulation outcome.
- The latter one in year 2 is lower than that of the integrated one.
- Depending on distribution two pollutants, firms' burdens can be different although their overall damage levels are the same.

→ To avoid distortions associated with the sub-optimal level of regulation, our model discourages a use of excessive forward-looking when the level of regulation is made sequentially & encourages retrospective reviews on existing regulations when a new regulation is introduced. .

*Thanks!!!*