On the Choice of an Environmental Tax's Base and the Optimality of the Regulator's Ability to Commit, when Consumers are Environmentally Conscious

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1. Introduction

- In recent years, ‘‘green consumerism’’ has received increasing attention in the domains of marketing and environmental policy.
  - ❖ Consumers’ concern for the environment appears to have had significant impact on their behavior in markets for goods
  - ❖ There is evidence that consumers are worried about the level of air and water pollution, they feel well-informed and they believe they can play a role in protecting the environment (see for example Eurobarometer (2014, 2020)). Thus, even in markets that "green" alternatives are not present, consumer's choice is influenced by the level of pollution.
  - ❖ The development of green products is emerging as a strategy for reaching out to increasingly environmentally conscious consumers, with the intention of capturing a price premium, increasing market share, or both.

- This paper develops a framework in which consumer's choices depend on each product's level of pollution and examines the effect of the level of consumer's awareness in designing optimal environmental tax policy.
    - ❖ By environmental tax policy we mean
        - ◎ Choice of tax base : Output v. Emissions Taxes
        - ◎ Choice of tax schedule : A single tax-rate or a tax-rate menu based on observed abatement

- We focus on cases where—independently of the tax-base—the regulator does not commit to a single tax-rate because either
  - ❖ Firms are able to commit first to a level of abatement
  - ❖ The regulator can relatively easily change a given tax-rate when it is optimal for him to do so
  - ❖ The regulator decides to offer firms a tax-rate menu instead of a given tax rate. Firms choose their tax-rate by committing to the required level of abatement.
    - ◎ This corresponds to non-linear tariffication of emissions.

2. Main results:

- As consumers consciousness increases,
    - ◎ the output tax provides increasingly higher abatement incentives
    - ◎ the emissions tax reduces the incentive for abatement
- Offering a tax schedule provides additional abatement incentive
    - ◎ Both, abatement and output reductions reduce the tax-base but non-commitment allows the firm to also reduce the rate applied to that base
    - ◎ The additional incentive created by non-commitment to a tax-rate is not always welfare increasing, for it may produce excessive abatement.
- The desirability of the additional incentive depends on the tax-base
    - ❖ Output taxes always provide greater abatement incentives
        - ◎ greater risk for over-abatement
    - ❖ Emissions taxes fail to provide adequate abatement incentives
        - ◎ the additional incentive is useful

3. Literature

- ***Optimal choice of environmental tax instrument in different settings***.

    - ⊚ Schmutzler and Goulder (1997) compare emissions and output taxes in a partial equilibrium framework and in the presence of imperfect monitoring of emissions

    - ⊚ Fullerton et al. (2001) and Cremer and Gahvari (2002) in a general equilibrium framework.

    - ⊚ Goulder et al. (1997) examine the interactions with pre-existing distortionary taxes.

- ***Green consumers***

    - ❖ Introducing environmental advertisement as an additional instrument and adjusting Pigouvian taxation

        - ⊚ Petrakis et al. (2005), Nyborg et al. (2006), Brouhle and Khanna (2007) and Sartzetakis et al. (2012)

- ❖ Assuming consumers to differentiate products according to environmental attributes, thus inducing some firms to produce greener varieties.
  - ◎ Vertical differentiation framework:
    - ➢ Bansal and Gangopadhyay (2003), Garcia-Gallego and Georgantzis (2009), Bansal (2008), Deltas (2013), Doni and Ricchiuti (2013))
  - ◎ Horizontal differentiation framework: Conrad (2005)
    - ➢ Gil-Molto and Varvarigos (2013) examine the case in which environmental consciousness leads consumers to devote resources to reduce pollution (participation in carbon offsetting schemes, donations to NGOs, etc).
    - ➢ Some of these papers show that increasing consumers' responsibility is not always welfare improving and in some cases may not even improve environmental quality.
- ■ Closest to this work: Constantatos, Pargianas, and Sartzetakis (2021)
  - ➢ The regulator can commit to a tax rate.

4. The model

- **Production & pollution**:

  - ❖ A product X produced by a monopolist at quantity q.

  - ❖ Marginal production costs are constant and, for simplicity, normalized to zero.

  - ❖ Production of each unit of X generates δ units of some harmful pollutant.

    - ➢ For simplicity we set $\delta = 1$.

- **Abatement:** Let v indicate the monopolist's total abatement, $v \in [0,q]$, thus,

  - ❖ Net emissions are:
    - ➢ $e = \delta q - v \geq 0, \qquad (\delta = 1)$

  - ❖ Cost of abatement:
    - ➢ $C = kv^2, \;\; k \geq 1 \qquad (k = 2)$

  - ❖ Total environmental damage generated form pollution:
    - ➢ $D = ze^2, \;\; z > 1$

■ Preferences

- ❖ Pure consumption-utility of the representative consumer from good X and the numéraire good M is:

  - ➢ $U = aq - \frac{1}{2}q^2 + M, \quad a > 0$

- ❖ Utility of environmentally aware consumers

  - ➢ $\widetilde{U}(q;\phi) = \begin{cases} (\alpha - \phi e)q - \frac{1}{2}q^2 + M, & e > 0, \\ U(q), & e \leq 0, \end{cases}$

- ❖ where ϕ is a taste parameter expressing **consumer's aversion for pollution**.

- Commonly, environmental awareness is introduced as higher utility from a good that its production is related to ***more abatement*** (see Labertini *et al.* (2014), Petrakis et.al.(2009), Sartzetakis et.al.(2012)), *i.e.,*

$$\hat{U} = (a + \theta v)q - \frac{1}{2}q^2 + M$$

  - where $\theta \geq 0$ measures consumers' environmental sensibility and the “abatement variable”, v, measures firm's environmental performance *i.e., (environmental) product quality*.
  - The above approach values **abatement** ***per se,*** while in our approach the consumer values the ***emissions reductions***.
  - Hereafter, we drop M by assuming that it is sufficiently large to avoid yielding corner solutions

■ Demand function

- ❖ Solving the consumer's maximization problem, yields

  - ◎ For $e \geq 0$: $p = a - (1+\phi)\,q$

    - ➢ social consciousness affects behavior like a self-imposed-but-never-paid per unit tax

  - ◎ Substituting e by $q - v$:

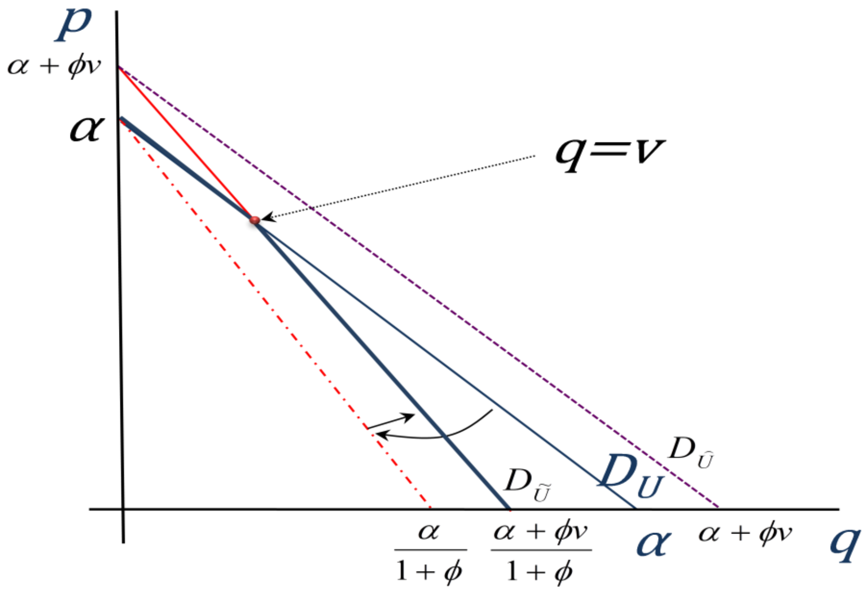
$$p = \begin{cases} (a + \phi v) - (1+\phi)q_i, & if\ q \geq v \\ a - q, & if\ q \leq v \end{cases}$$

    - ➢ Note that we do not replace e by $q - v$ before the derivation:

      - – The consumer ignores the impact of his consumption choice on emissions (externality)

    - ➢ The demand curve is depicted below.

◎ *The Demand function*



❖ The figure illustrates the green consumer's kinked Demand curve (denoted by $D_{\tilde{U}}$), consisting of the segment of the pure consumption-utility (denoted by D_U) up to $q = v$ and for greater values of q, of the shifted demand curve (solid red line).

❖ The figure also illustrates the green consumer's demand corresponding to the usual assumption that "consumers better like cleaner products" ($D_{\hat{U}}$).

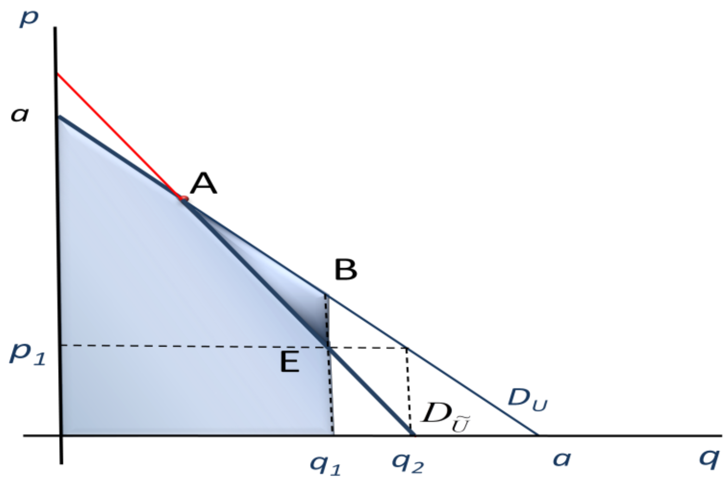
Social welfare

- ***W = UU – D – C*,** where $D = z(q-v)^2$ and $C = kv^2$
- The question is "**what do we replace *UU* with?**"
- Standard ***Hedonic*** approach: $UU = \widetilde{U}$, *i.e.*,

$$\widetilde{W} = \widetilde{U} - D - C = \begin{cases} (a-\phi e)q - \frac{1}{2}q^2 - (z-v)^2 - kv^2, & \text{for } q \geq v \\ U - kv^2, & \text{for } q \leq v \end{cases}$$

- We assume that ***social responsibility*** **affects behavior, but does not affect consumption value,** hence that $UU = U$, *i.e.*,
- $W = U - D - C = \begin{cases} aq - \frac{1}{2}q^2 - (z-v)^2 - kv^2, & \text{for } q \geq v \\ U - kv^2, & \text{for } q \leq v \end{cases}$
- We do not allow consumers to internalize more than 100% of the environmental damage: $\phi \leq z$.

- The difference in the two approaches is shown on the following figure



- Under both approaches, at the given price p_1 the environmentally conscious consumer consumes q_1 instead of q_2.

- ***What is the total value (willingness-to-pay) attributed to that quantity?***

  - ***Hedonic approach***: the surface $0a$AE q_1

    - the regulator takes into account the "anxiety" that consumption causes to environmentally conscious consumers

  - ***This paper***: the surface $0a$Bq_1

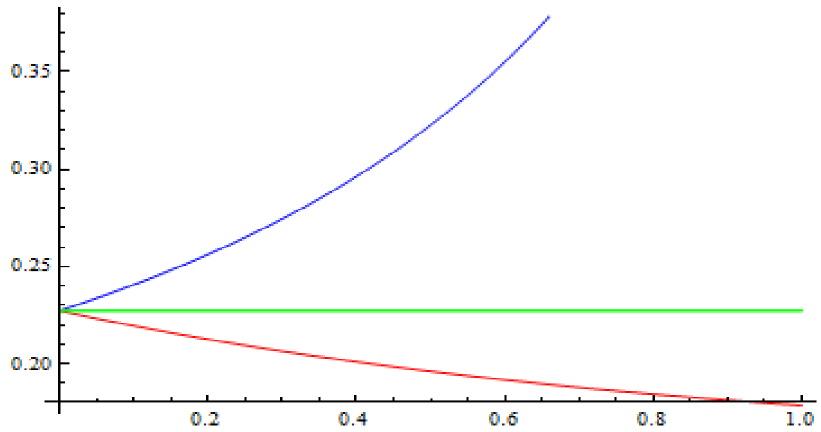
■ First Best

- ❖ By first best we mean a situation where the regulator chooses both quantity and abatement
- ❖ The regulator maximizes

$$W = U - D - C = \begin{cases} aq - \frac{1}{2}q^2 - (z - v)^2 - kv^2, & \text{for } q \geq v \\ U - kv^2, & \text{for } q \leq v \end{cases}$$

  - ➢ For simplicity we ignore the possibility that $q < v$.

- ❖ The Figure below depicts first-best welfare as function of ϕ under three alternative formulations



- Social Responsibility (**GREEN** line)
- Hedonic when the consumer loves abatement (**BLUE** line)
- Hedonic when the consumer hates emissions (**RED** line)

❖ **Social responsibility approach:** the first best is independent of ϕ

❖ Hedonic approaches: first best depends on ϕ (positively or negatively)

- Social sensibility creates (or destroys) value *per se.*
- It can also be shown to affect the regulator's decisions
- The Regulator chooses quantity and abatement in order to satisfy consumers' feelings (warm glow effects)

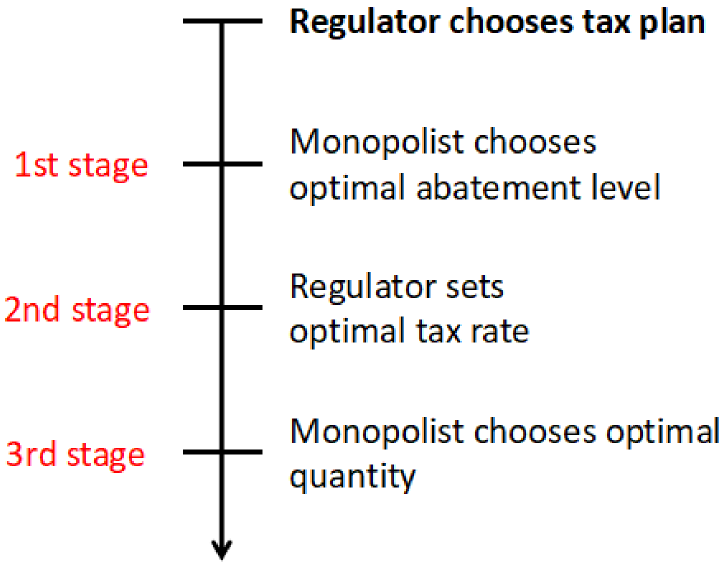
5. Game Structure and Government Intervention

❖ Three-stage game:

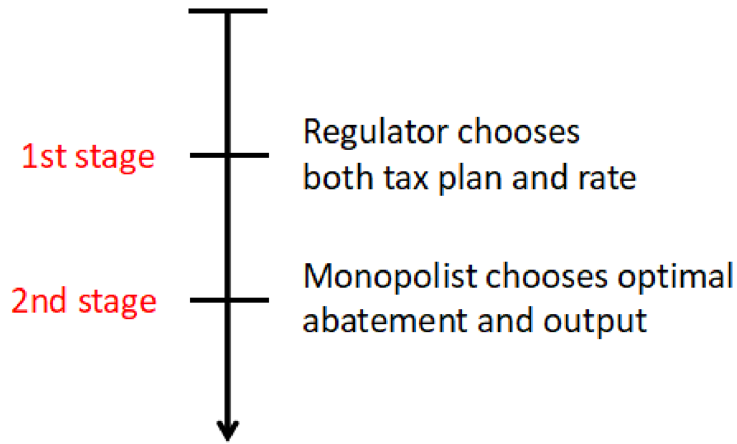
◎ **first stage**: the monopolist decides its abatement level;

◎ **second stage**: the regulator imposes an emissions or output tax rate;

◎ **third stage**: the monopolist chooses output (or price)



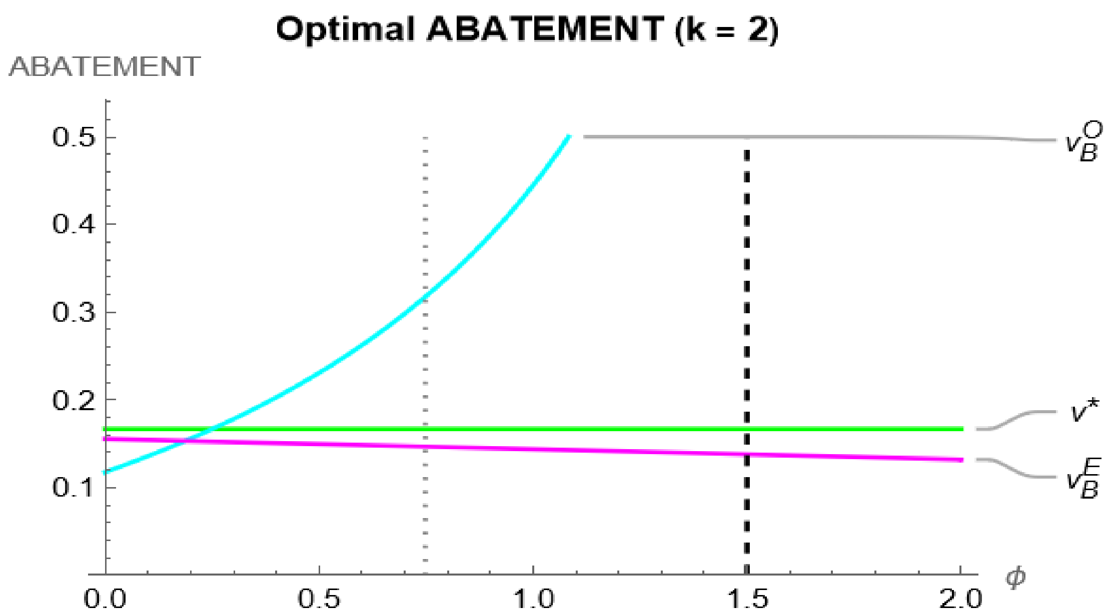
Constantatos C., Martis A.



Constantatos C., Pargianas C., Sartzetakis E., S (2021)

6. Abatement Comparisons between output and emissions tax

■ **No commitment**



❖ As ϕ increases, the abatement incentive provided by an output tax increases (cyan line), while that provided by an emissions tax decreases (magenta line).

◎ After the gray dotted line the emissions tax becomes zero (no emissions subsidy allowed)

◎ After the black dotted line, emissions under an output tax become zero.

➢ Limit the analysis to the interval until the gray dotted line.

- Increases in consumers' consciousness generally call for lowering the tax rates, whether on emissions or output, since consumers internalize part of the environmental externality by reducing demand.

- A reduction of the ***output-tax rate*** works like a subsidy, boosting output.

    - Since abatement is a fixed cost, higher output lowers the cost of abatement per-unit of output, naturally providing a greater abatement incentive.

    - As ϕ increases, the output-tax rate may become negative (output subsidy)

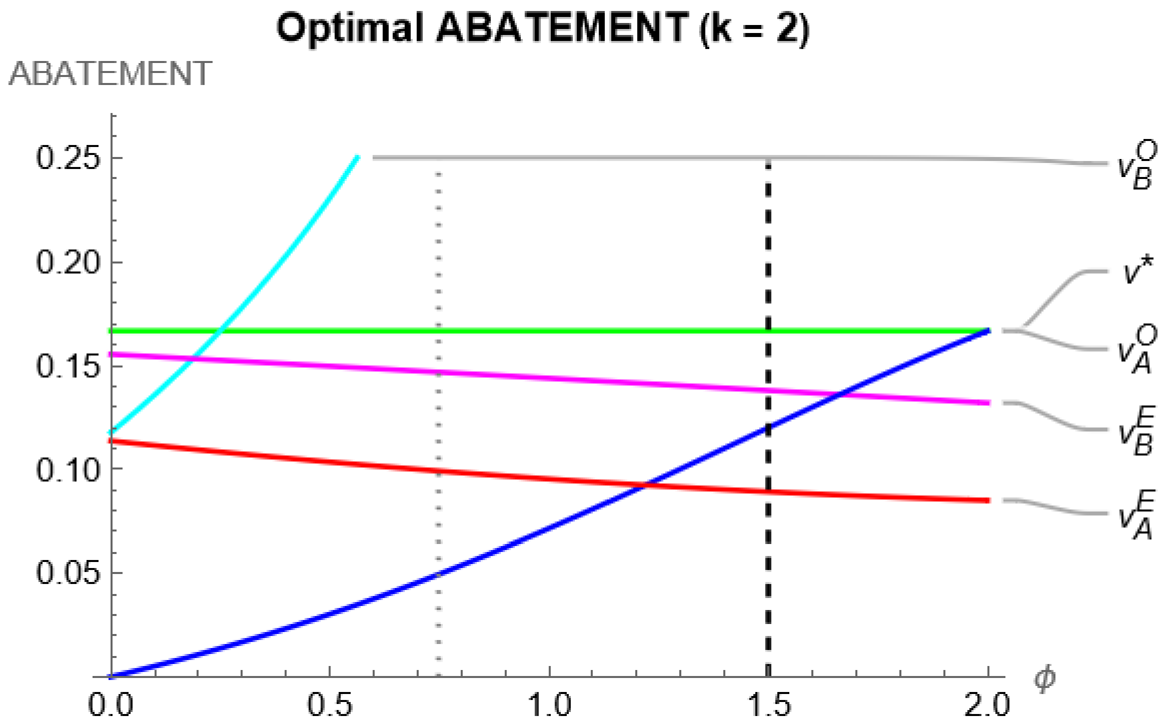
    - At relatively low levels of ϕ the output tax already generates more abatement than the 1st best

        - Over-abatement (too little consumption of the numéraire)

- A reduction of the ***emissions-tax rate*** due to an increase in consumer consciousness corresponds to making emissions less costly, thus *curtailing* the firm's incentive for abatement.

    - The abatement incentive provided by an environmental tax based on emissions decreases as consumers become more environmentally conscious

■ **Commitment vs Non commitment**

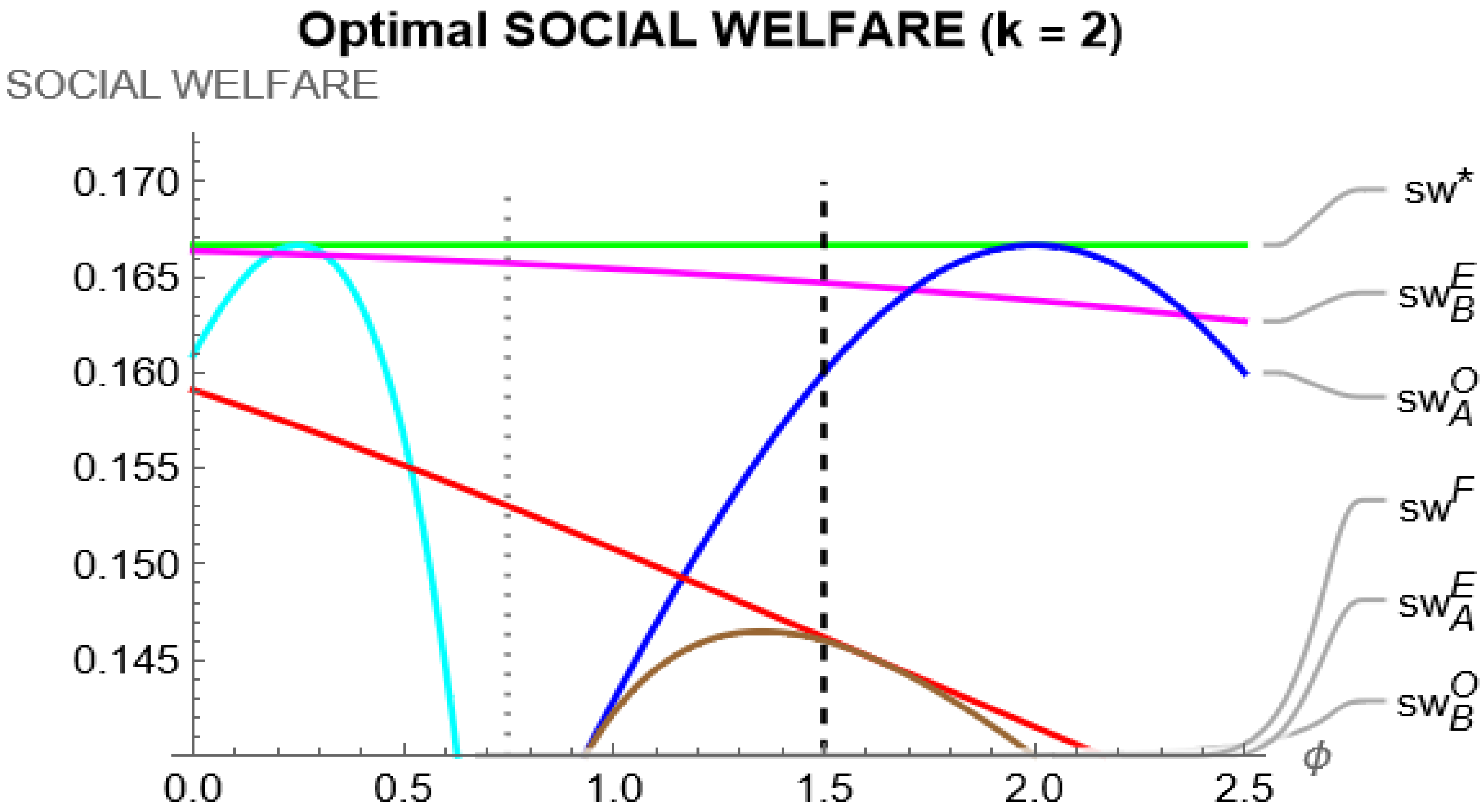


❖ Legend:

- Sup O and E: the tax is on output or emissions
- Sub A and B: commitment or no commitment to a tax rate
- Green line: First Best

- By eliminating commitment
  - Both the Blue and Red lines shift upwards to the Cyan and Magenta position, respectively.
  - The emissions-tax generated abatement moves closer to that of 1st best
  - The output-tax generated abatement quickly reaches its 1st best level and surpasses it

7. Total welfare

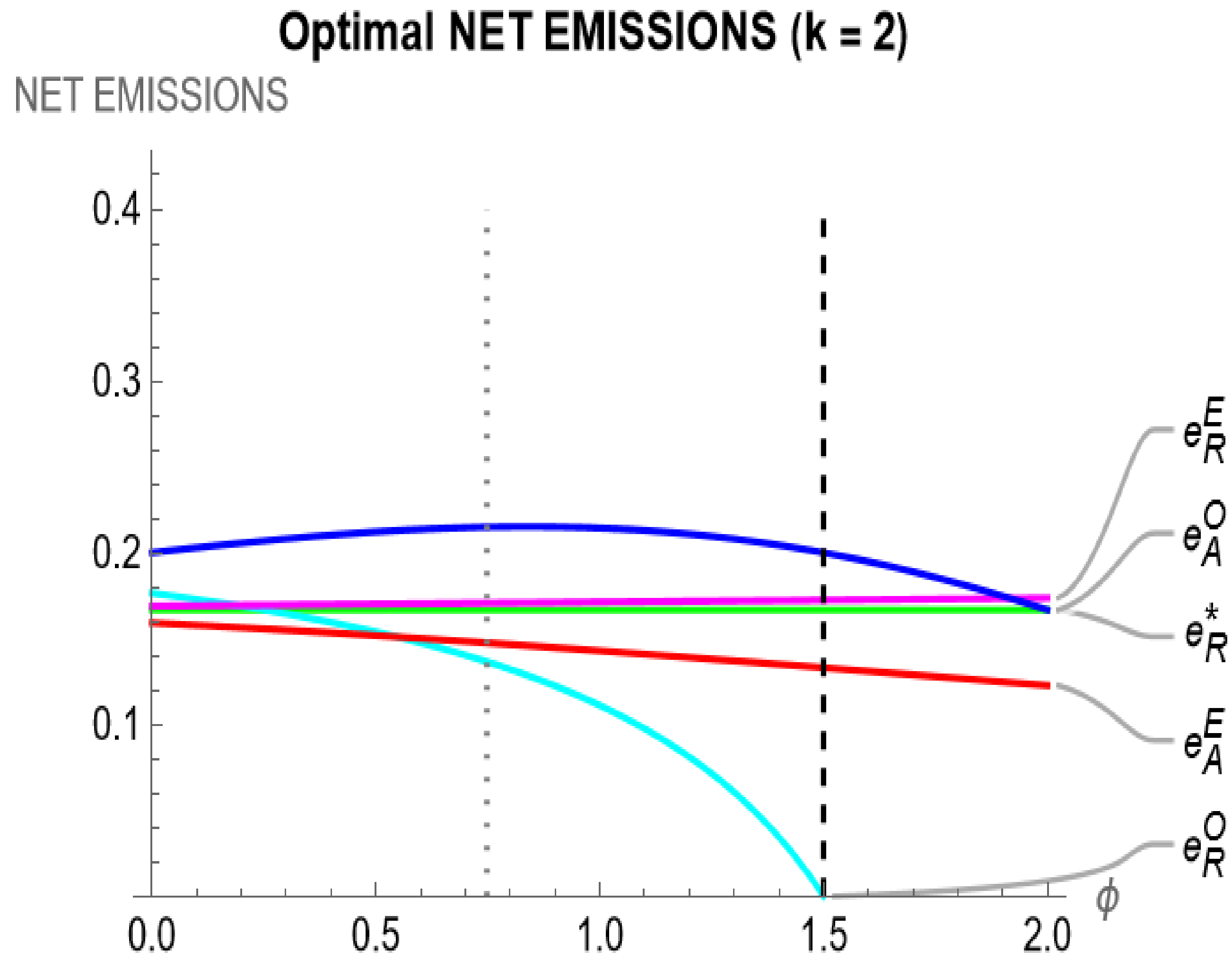


❖ Legend:

- Superscript *O* and *E*: the tax is on output or emissions
- Subscript *A* and *B*: commitment or no commitment to a tax rate
- Green line: ***First Best*** // Brown line: *Free market (no tax)*

- Without commitment
  - Superiority of Output tax for a limited range of values of ϕ
  - Welfare declines under an output tax because of too much abatement
  - The emissions tax is a safer alternative
- By eliminating commitment
  - Output tax: the **Blue** line moves leftwards to the **Cyan** position
  - Emissions tax: the **Red** line moves upwards to the **Magenta** position
    - Non commitment
      - improves the performance of the emissions tax while
      - it has an overall ambiguous (and rather negative) effect on the performance of the output tax
    - If the regulator does not know ϕ the emissions tax is the safer solution

8. Net Emissions



- In the absence of commitment, the output tax generates less emissions, unless environmental consciousness is very low.
    - For most values o ϕ, net emissions under the output tax are lower than their first-best level
- In case of commitment, the emissions tax produces always lower emissions.
    - Even lower than their first-best level

9. Conclusions

- We have completed the comparison between environmental tax bases contained in CPS by adding the possibility that the regulator adjusts the tax rate in face of changes in observed abatement
- We assume
  - Consumers to be environmentally ***responsible***
    - Responsible consumers do not devalue their consumption, instead they reduce it voluntarily as if they were paying a tax
      - Responsibility is interpreted as a voluntary contribution to a public good.
  - Firms to have the possibility of end-of-pipe abatement
  - The Regulator to consider the value of consumption without warm-glow effects (whether positive or negative)

- We conclude that

  ❖ In the absence of commitment to a tax rate, the emissions tax-base yields higher welfare

  ❖ Even if the regulator has the power to commit to a tax rate, by not committing he can obtain higher welfare, unless consumers' consciousness is sufficiently high

    ◎ Non commitment corresponds to offering a tax menu consisting of the regulators best reply to any observed abatement level.

  ❖ If the value of ϕ is unknown, an emissions-tax menu based on abatement is the safest solution

Thanks for your attention !