The Ambiguous Case for Letting Regulators Tailor Standards

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Abstract

Restrictions preventing regulators from setting standards on a firm-by-firm basis are commonly assumed to be inefficient and existing rationales for their prevalance have been politico-economic. We provide an efficiency-interpretation. Whilst the requirement that regulation be uniform does not allow the agency to commit to future standards, it does mean that what is required from one firm it must be required of them all. This does not 'tie the hands' of the agency, it does restrict their movement in such a way as to make an individual firm less reluctant to disclose its access to low-cost compliance technologies, and so offers partial mitigation of the ratchet effect. We characterise settings in which a constitional requirement that standards be uniform is (a) definitely desirable, (b) definitely undesirable, and (c) where the case is ambiguous. **Keywords: Environment - instrument-design - ratchet effect.**

1 Background

In many settings regulators are required to treat firms uniformly. In the environmental context this may mean having to use uniform rather than firm-specific or differentiated emissions standards. Kolstad (1987) identifies a number of legal and constitutional bases for such requirements, and also notes that ". . . it is often considered (rightly or wrongly) inequitable and inappropriate to let regulators to treat polluters differentially, or on a firm-by-firm basis" (Kolstad (1987: 591).

The potential benefits of tailoring regulation to fit the circumstances of individual polluters is a recurrent theme in the literature. Standard analysis suggests that a requirement that standards be the same on all firms will be inefficient in a world of heterogeneous compliance costs. First-best standard-setting requires that firm-specific standards be set such as to equate the marginal costs and benefits of abatement at the firm-level.

Administrative or other transactions cost considerations may, of course, dissuade the unrestricted agency from setting the fully-differentiated vector of standards compatible with first-best.[1] But giving a welfare-maximising EPA the flexibility to tailor standards cannot, a commonly-heard argument runs, be welfare-reducing, since the worst the agency can do is opt to set undifferentiated standards and hence do no worse than it would have been able to do under a requirement of uniformity. Kolstad (1987) and Baumol and Oates (1988) are amongst those who have evaluated the loss associated with uniformity theoretically, Parry and Williams (1999) provide a numerical evaluation.

In a recent paper, Boyer and Laffont (1999) provide a political-economic rationale for a constitution imposing (apparently) inefficient policy instruments. Their justification lies in the limitations that such instruments impose on the ability of politicians to distribute rents. Mandating the use of inefficient instruments (standards rather than taxes, undifferentiated rather than differentiated quotas) can, similarly, solve agency problems that might arise between the legislature (as principal) and the EPA (as agent).[2]

[1] Tietenberg (1978) was early to recognise that such costs could be substantial. They point to the administrative benefits of coarser differentiation in the form of categorical or 'banded' standards, of the sort commonly seen in practice.

[2] A regime equipping an EPA with the discretion to award firm-specific easements of regulatory standards may, for example, encourage more rent-seking from the regulated population than one in which the EPA has no such discretion.

Such agency considerations do not feature here. In the current model, a welfare-maximising EPA may be able to perform better under a stricture that it set uniform standards than if it were left unfettered.

A requirement that regulation be uniform does not 'tie the hands' of the agency in the usual way, but does inhibit their movement.[3] Whilst it doesn't permit (or require) commitment to future regulatory stringency, it does imply that what is required from one firm in an industry must be required from all the others. In so doing it makes an individual firm less reluctant to disclose its access to low-cost compliance technologies and partially mitigates the ratchet effect.[4] The benefits of such mitigation must be weighed against the inefficiencies conventionally associated with uniformity.

2 A Model

Consider a two-period model. At the start of each period the regulatory agency (the 'EPA') sets an emissions standard for each of a large number of firms in a population. The level permitted by firm i will be denoted s_i, and exact compliance with the vector of standards is assumed to be fully and costlessly enforced.[5]

Every firm has access to an established or 'back-stop' abatement technology which allows it to reduce its emissions to a level e at a cost

$$\theta_H.c(e) > 0$$

where $c' < 0$, $c'' > 0$ (the marginal product of abatement spending is everywhere positive but diminishing). A fraction of firms α also have access to an alternative (lower cost) abatement technology which allows them to

[3] There exists, of course, a much wider literature on the benefits of 'tying the hands' of policymakers (and the benefits of rules over discretion), especially in application to the operation of monetary policy. Panagariya and Rodrik (1993) and Haaporanta and Puhakka (1993) are examples.

[4] For a general treatment of the ratchet effect see Freixas *et al* (1985) or Laffont and Tirole (1993). Recent applications include Meyer and Vickers (1997) and Dalen (1997).

[5] A regulatory standard s_i is, of course, the same as a non-tradeable pollution quota. We do not consider other instruments, restricting our attention to a comparison of differentiated and undifferentiated standards. There are a variety of reasons why alternatives (such as pollution taxation) may be ruled out, or may generate other sorts of inefficiency. Note that this is not a mechanism design problem, and that the EPA does not have the power to tax or spend, it simply sets standards.

reduce emissions equivalently at a cost $\theta_L.c(e)$, $\theta_L < \theta_H$.[6] We will refer to firms that do and do not have access to the alternative as L and H-types respectively. Whilst H-type firms have no choice of technique, L-types can choose between the two technologies.

The regulatory agency is assumed unable to observe which firms in the population have access to the alternative technology (though it knows α) but can observe realised compliance costs *ex post*.

The agency minimises a social loss function

$$\sum_{t=1,2} \left(\sum_i d.s_i + \sum_i \theta_i.c(s_i) \right), \tag{1}$$

the two-period sum of environmental damage and realised compliance costs.[7] It is unable to commit to future standards (*i.e.* to second period standards at the start of period 1).

The objective here is to characterise optimal regulation under two scenarios - one in which the agency is free to set standards on a firm-by-firm basis, one in which it is obliged to set undifferentiated standards - and to compare the outcomes achieved.

2.1 Second period regulation

The EPA's second period problem is conventional, and we solve it first.

Suppose, initially, that the EPA (a) has been able to separate firms by observing realised compliance costs in period 1 and, (b), is allowed to tailor standards. There is no incentive for any firm to choose other than the least cost compliance technology available to it, so the EPA will impose period 2 standards s_L and s_H on L and H type firms where s_j is characterised by

$$-\theta_j.c'(s_j) = d, \tag{2}$$

$j \in \{L, H\}$. Convexity of $c(s)$ implies that $s_H > s_L$ - firms with low marginal abatement costs will face tougher standards - which is conventional.

[6] As usual 'technology' should be interpreted broadly to include organisational reform, adjustment of work practices, change in product mix, relocation *etc.*.

[7] As the aim here is to keep things as simple as possible, subject to establishing our main result, we have assumed an unweighted sum. An interesting (and straight-forward) extension would be to see how the comparative performance of tailored and untailored standards varied with differing weights placed on the components of social loss (to reflect 'pro-industrial' and 'pro-environmental' motivation).

Under 'perfectly tailored' regulation of this type the second period social loss (denoted Λ) can then be written

$$\Lambda \equiv \alpha.(d_L + \theta_L c(s_L)) + (1-\alpha).(d_H + \theta_H c(s_H)). \tag{3}$$

Suppose, instead that the EPA (a) has not been able to separate firms by observing realised compliance costs in period 1 and/or, (b), is prevented by its mandate from tailoring standards. Again, given that this is the last period there is no incentive for any firm to choose other than the least-cost technology available to it. The agency, however, is required to choose a uniform standard to apply to all firms, and will set that standard, s_U, to satisfy

$$-(\alpha.\theta_L + (1-\alpha).\theta_H).c'(s_U) = d, \tag{4}$$

i.e. to equate average marginal cost with marginal damage, with the former conditioned on efficient choice of technique. It is straight-forward to verify that $s_H > s_U > s_L$, the optimal uniform standard lies somewhere between the respective tailored standards. Second period social loss under optimal uniform regulation, to be denoted Γ, can then be written

$$\Gamma \equiv d.s_U + (\alpha.\theta_L + (1-\alpha).\theta_H).c(s_U)). \tag{5}$$

It is apparent that

$$\Lambda < \Gamma,$$

which is intuitive. The difference between Λ and Γ measures the periodic benefits of regulatory tailoring under complete information or, alternatively, the value of complete information when regulatory tailoring is permitted.

2.2 Regulation in period 1

First period regulation is more difficult to characterise because we can no longer presume efficient choice of compliance technology by all firms. In particular, the knowledge that realised period 1 compliance costs will be observed by the EPA and could influence future regulation may induce L-type firms to choose the high-cost technology.[8] The incentive for such behaviour will depend upon the extent to which the EPA is allowed to tailor second

[8] Recall that all firms have access to the high-cost technology, but only some subset of firms (the L-types) have access to the low-cost alternative.

period standards. The mandate the EPA operates under - whether that mandate permits or prohibits tailoring - matters critically for regulation in period 1. This is the case even though tailoring, should it be allowed, will never actually be used until period 2.

2.2.1 Tailoring prohibited

Suppose that the EPA is restricted to setting uniform (untailored) standards.

From the point of view of any individual firm the standard it will face in period 2 is s_U and is independent of its choice of technique in period 1. Hence each firm chooses the least cost compliance technology available to it and the EPA can do no better than set the uniform period 1 standard equal to s_U also.

Under a mandate restricting it to set untailored standards, then, the EPA will set a uniform standard s_U in each period, and the choice of technique will be efficient in both. Resulting two-period social loss can be written

$$L^U = 2.\Gamma. \tag{6}$$

This provides a benchmark against which the compare performance when tailoring of standards is permitted.[9]

2.2.2 Tailoring allowed

When tailoring is allowed the L-type firms choice of technique is ambiguous. Because realised compliance costs are observed by the EPA, the representative L-type anticipates that using the low cost technology to which it has access will allow the EPA to infer its type and so will ensure that it will face a tailored standard s_L in period 2.

Since firms are *ex ante* identical the EPA sets a uniform period 1 standard. In so doing it has respect for the incentives that the standard it sets has for choice of technique. We can usefully distinguish between three types of outcome.

[9] L^U will be used to denote two period social loss under a mandate of uniformity, given that the EPA behaves optimally (as described). L^T will the the equivalent for the case in which tailoring is permitted. The superscript, then, describes the mandate under which the regulator operates, rather than what realised regulation actually looks like. Even when tailoring is permitted the EPA may, under certain circumstances, choose to set a uniform standard. It is also worth re-emphasising that tailoring matters for period 1 standard-setting, even though those period 1 standards will never themselves be tailored.

We will say that 'natural separation' occurs when the EPA setting a myopically-optimal period 1 standard - without regard for the efficiency of future regulation - results in efficient choice of technique. Since the myopically-optimal standard (that which minimises in-period social losses conditional upon efficient choice of technique) is, by definition, s_U, natural separation will occur if and only if

$$\theta_L.c(s_U) + \theta_L.c(s_L) < \theta_H.c(s_U) + \theta_L.c(s_H), \tag{7}$$

which can be re-expressed as

$$c(s_U) > \left(\frac{\theta_L}{\theta_H - \theta_L}\right).(c(s_L) - c(s_H)). \tag{8}$$

The left-hand side of 7 is the total expected compliance cost of an L-type firm that uses the low-cost technology in period 1, in so doing reveals its type and so faces tailored regulation s_L in period 2. The right-hand side is the cost to the same firm from using the high-cost technology (symmetry implies that if the condition holds for one L-type firm, it will hold for them all, which is why the final term on the right-hand side in 7 is $\theta_L.c(s_H)$ rather than $\theta_L.c(s_U)$).

In its re-expressed form in 8, the inequality says that the representative firm with access to the low cost alternative technology will use it in period 1 - hence 'showing his hand' to the agency and setting itself up for tougher regulation later - when and only when the short-run compliance cost savings are if enough. More concretely, when and only when s_U is small enough to make $c(s_U)$ exceed the expression on the right-hand side of 8.

In this case the minimum achievable two-period social loss when tailoring is allowed can be written

$$L^T_{natural\ separation} = \Gamma + \Lambda \tag{9}$$

This leads straight-forwardly to the following:

Proposition 1 *If the parameters of the problem are compatible with natural separation then the EPA, under a mandate permitting tailoring, will set a uniform standard s_U in period 1 and perfectly tailored standards in period 2. Welfare is strictly higher when tailoring is permitted than when it is not.*

The welfare result follows from the fact that

$$L^T_{natural\ separation} = \Gamma + \Lambda < 2\Gamma = L^U. \tag{10}$$

Whether or not tailoring is allowed the optimal first-period standard here is s_U, choice of technique is efficient (such that firm types are fully revealed) and social loss in period 1 is Γ. The resulting complete information at the start of period 2 means that the lowest achievable social loss in period 2 is Λ if tailoring is allowed, Γ if not. The logic for the finding that allowing tailoring is welfare-improving when natural separation occurs is straight-forward. The agency does not have to compromise the efficiency of period 1 regulation in order to induce L-types to reveal themselves (which is why we say that separation occurs 'naturally'), but can benefit from being allowed to exploit that information in period 2.

More interesting are contexts in which the inequality in 8 is not satisfied, such that setting s_U in period 1 induces pooling in choice of technique (*i.e.* all firms will choose the high-cost compliance technology in period 1). If the EPA wants choice of technique in period 1 to be efficient - which has two advantages (a) it reduces period 1 compliance costs and (b) provides the informational basis for subsequent tailoring - it has to induce it strategically. Separation is induced by the setting of a period 1 standard less than or equal to s_{SS} where

$$c(s_{SS}) = \left(\frac{\theta_L}{\theta_H - \theta_L}\right).(c(s_L) - c(s_H)), \tag{11}$$

(the SS subscript denotes 'strategic separation').When $s_{SS} < s_U$ - that is, when separation does not occur naturally - convexity of c means that the 'best' period 1 standard inducing separation is s_{SS}, just tight enough to induce separation and no tighter.

Strategic (as opposed to natural) separation means that the efficiency of period 2 regulation is maintained (second period social loss is Λ), but at the expense of efficiency in period 1. Whilst choice of technique in period 1 is efficient, that efficiency has had to be induced by the setting of an inefficiently tough standard $s_{SS} < s_U$ (*i.e.* one tighter than its first-best counterpart). Social loss in period 1 in this case will be denoted Υ and can be written

$$\Upsilon(s_{SS}) = d.s_{SS} + (\alpha.\theta_L + (1-\alpha).\theta_H).c(s_{SS}). \tag{12}$$

Noting that $\Upsilon'(s_U) = 0$ (by construction) and $s_{SS} < s_U$, convexity of the regulatory problem implies $\Upsilon'(s_{SS}) < 0$ and, further, $\Upsilon(s_{SS}) > \Upsilon(s_U) = \Gamma$.

The lower (and hence the further below s_U) the period 1 standard has to be set to induce separation the higher is period 1 social loss.

Proposition 2 *If the parameters of the problem are such that under a mandate permitting tailoring the EPA chooses to induce separation strategically, then welfare when tailoring is permitted may be higher, lower or the same as it would be if tailoring were prohibited.*

Two-period social loss under strategic separation is

$$L^T_{strategic\ separation} = \Upsilon(s_{SS}) + \Lambda \tag{13}$$

such that

$$L^T_{strategic\ separation} - L^U = (\Upsilon(s_{SS}) - \Gamma) + (\Lambda - \Gamma) \gtreqless 0 \tag{14}$$

The ambiguity follows because $\Upsilon(s_{SS}) > \Gamma$ and $\Lambda < \Gamma$. Period 1 social loss, $\Upsilon(s_{SS})$, is higher under strategic separation than it would be if tailoring were prohibited, Γ - in each case choice of technique is efficient but in the latter case the standard is at the first-best uniform level (s_U), in the former the regulator has been obliged to set it more stringently ($s_{SS} < s_U$). Period 2 social loss, however, is lower, reflecting the usual gains from differentiating standards under complete information.

It is commonly argued that giving a regulatory agency additional powers or additional flexibility must improve its performance, at least weakly, because the regulator can always opt not to use those powers. The inability of the EPA to commit not to use them combined with its inability to compel efficient choice of technique means that such an argument does not fit here.

Suppose that under a mandate permitting tailoring, the agency finds that the best strategy is *not* to induce separation. In the resulting equilibrium, then, all firms use the high-cost technology in period 1 such that the best standard it can set in period 1 - denoted s_{BP} - will be described by

$$d = -\theta_H.c'(s_{BP}). \tag{15}$$

In period 2 choice of technique will, as always, be efficient, such that optimal standard will revert to s_U. The resulting two-period social loss can then be expressed thus:

$$L^T_{best\ pooling} = (d.s_{BP} + \theta_H.c(s_{BP})) + \Gamma. \tag{16}$$

We can first of all note the following:

Proposition 3 *Under a mandate permitting tailoring, if the parameters of the problem do not imply natural separation then the EPA will choose to implement the best available pooling equilibrium if*

$$(d.s_{SS} + (\alpha.\theta_L + (1-\alpha).\theta_H).c(s_{SS}))) + \Lambda > (d.s_{BP} + \theta_H.c(s_{BP})) + \Gamma. \quad (17)$$

It will choose to induce strategic separation otherwise.

The left and right-hand sides of 17 are simply $L^T_{strategic\ separation}$ and $L^T_{best\ pooling}$ respectively. The Proposition merely reasserts that the EPA will choose the option that minimises two-period social loss.

We have already noted (Proposition 2) the ambiguous welfare impact of allowing the EPA to tailor standards for the case in which strategic separation is the preferred policy. Is the ambiguity preserved when the preferred policy involves implementing the best available pooling equilibrium?

Noting that

$$(d.s_{BP} + \theta_H.c(s_{BP})) = \min_s \{d.s + \theta_H.c(s)\} \quad (18)$$

whilst

$$\Gamma = \min_s \{d.s + (\alpha.\theta_L + (1-\alpha).\theta_H).c(s))\}, \quad (19)$$

it is apparent that

$$L^T_{best\ pooling} > 2.\Gamma = L^U. \quad (20)$$

This can be summarised as follows.

Proposition 4 *If, under a mandate permitting tailoring, the parameters of the problem are such that the EPA chooses to implement the best available pooling equilibrium, then welfare would be enhanced if tailoring were prohibited.*

In either case the period 2 loss is Γ (in one scenario the EPA arrives at the start of period 2 not knowing which firm is of which type, in the other it knows, but can't do anything with that knowledge). When tailoring is prohibited choice of technique in period 1 is efficient (no firm has any incentive to conceal their true type) and s_U achieves an in-period loss also equal to Γ. In a pooling equilibrium, in contrast, choice of technique in period 1 is inefficient (by definition), the lowest level of social loss is achieved by setting a standard $s = s_{BP} < s_U$ but that social loss will necessarily exceed Γ.

If the agency, then, is not going to use the right to tailor standards, it is strictly better off not to have those rights. Redundant powers are not harmless, here, because it is the anticipation that the agency *could* tailor period 2 standards which drives the inefficient choice of technique in period 1 (dissuading L-type firms from using the least cost technology available to it).[10]

Even if it does use those powers, it may still be better off not to have them (recall Proposition 2). It is not appropriate to claim that because they are used they are necessarily useful. A regulatory mandate requiring uniform standards will be optimal when the expression in 14 is positive, even though having been given the power to tailor the EPA may minimise loss by using that power.

A mandate that prohibits tailoring provides the agency with a measure of commitment. Whilst it doesn't allow commitment to future standards, it does imply that what is required from one firm in a population must be required from all the others. Because the EPA cannot raise standards on L-types without also raising them on H-types, it restricts the extent to which it does so, and makes an individual firm less reluctant to act in a way that reveals it to be an L. As such the mandate partially mitigates the ratchet effect. These benefits must be weighed against the inefficiencies usually associated with uniformity. The net effect can, as our analysis has shown, go either way.

2.3 A digression on voluntary over-compliance

In setting things up at the start of Section 2 we were careful to specify that the agency enforced exact compliance with standards - *i.e.* that firm i was required to emit at a rate exactly equal to the standard imposed on it.

It is much more natural, however, to think of firms being required to emit at a rate not exceeding the standard (that is to think of enforcement being 'single tailed'). Re-specifying things in this way throws up the intriguing possibility that, under tailoring, H-type firms could use voluntary

[10] In many settings regulatory powers are not, in equilibrium, used, but are still exerting a positive influence on the characteristics of the outcome (*e.g.* the threat of a big penalty may prevent wrong-doing such that in equilibrium that penalty never has to be levied). Here the reverse applies.

over-compliance with the first period standard as a credible signal of type, thus securing more lenient treatment later.

To illustrate the possibility suppose that the EPA sets a uniform period 1 standard s_1 (we are not, here, concerned with how s_1 was set). To construct a signaling equilibrium we must identify a level of emissions $s_{signal} < s_1$ such that if the EPA observes a firm emitting at that level, with realised compliance costs $\theta_H.c(s_{signal})$, it will infer that it is H-type, otherwise it will infer that it is L-type, and that those inferences will be correct.[11]

To satisfy these requirements it must be the case that both types subscribe to it, given the rule of inference operated by the EPA. The representative H-type will subscribe (will signal) if

$$\theta_H.c(s_{signal}) + \theta_H.c(s_H) < \theta_H.c(s_1) + \theta_H.c(s_L). \tag{21}$$

The representative L-type will subscribe (*i.e.* will *not* signal) provided

$$\theta_H.c(s_{signal}) + \theta_L.c(s_H) > \theta_L.c(s_1) + \theta_L.c(s_L). \tag{22}$$

For any s_{signal} satisfying both 21 and 22 it is apparent that the rule of inference operated by the EPA is valid (Bayes-consistent).

Depending upon parameter values and the specification of c we may or may not be able to construct such an equilibrium, that is may or may not able to find a value (or interval of values) for s_{signal} satisfying 21 and 22 simultaneously. If such an interval exists then there will exist a corresponding continuum of PBE's. That associated with the highest value of s_{signal} is the only one satisfying the Intuitive Criterion - *i.e.* H-types will do 'just enough' to credibly signal their type, and no more (Cho and Kreps (1987)).

The model provides a new possible rationale for the emergence of voluntary agreements (VA's) - agreements by which some sub-set of firms in an industry agree to levels of environmental performance in excess of regulatory requirements. Here, they arise endogenously and as a signaling device - a subset of firms use over-compliance in period 1 as a credible signal of type such as to secure less stringent treatment in period 2.

[11] Such an equilibrium would be a Perfect Bayesian Equilibrium (PBE). Gibbons (1992) provides a good textbook treatment of PBE's and ther refinement. Note that given the current structure we need the qualification that "realised compliance costs be $\theta_H.c(s_{signal})$". Any firm emitting at a rate s_{signal} but realising costs $\theta_L.c(s_{signal})$ would immediately, of course, be revealed to be an L.

Several features of VA's motivated by signaling are worth noting. (a) If VA's do arise they will involve *high*-cost firms. This is contrary to the conventional view that firms signing-up to VA's will tend to be those which find over-compliance comparatively cheap.[12] (b) An implication of this is that efforts to infer cost of industry-wide abatement from the costs incurred by VA participants will tend to lead to *over*-estimation (again, the reverse of conventional wisdom). Furthermore, (c), VA's will not emerge when the EPA is prohibited from tailoring.

We do not pursue this in any additional detail - flagging it as something of potential interest preferring to retain the original assumption of exact enforcement.[13] It raises certain other questions, such as how the EPA might manipulate s_1 to facilitate the emergence of VA's, some of which are dealt with in Heyes (1999).

3 Conclusions

There is a large and growing body of literature which aims to compare the efficiency of alternative instruments of environmental regulation, and to characterise their optimal use. Weitzman (1974), Besanko (1987) and Stavins (1996) are three well-known examples.

In this paper we have examined the comparative efficiency of two instruments - uniform emissions standards and firm-specific emissions standards - in a simple two-period model in which firms have private information about their access to low-cost abatement techniques. The analysis showed that if the power to tailor standards is not going to be used by the agency, then those powers should be taken away (this is not a case of redundant but irrelevant). Even if the agency opts to use those powers, it may be welfare-improving to remove them. The view that differentiated standards will dominate their uniform counterparts is not, in general, defensible.

[12]The collection of essays in Carraro and Leveque (1999) can be taken as reflective of conventional wisdom in this field. In the current model, over-compliance acts as a credible signal for H-types precisely *because* the additional cost incurred is so great.

[13]Or, equivalently, to the assumption that functional forms and parameter values are such that 21 and 22 cannot be simultaneously satisfied.

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