Journal of Public Economics 120 (2014) 169–180

Contents lists available at ScienceDirect

Journal of Public Economics

journal homepage: www.elsevier.com/locate/jpube

Dynamic regulation design without payments: The importance of timing ☆

Raphael Boleslavsky *, David L. Kelly

Department of Economics, University of Miami, Box 248126, Coral Gables, FL 33124, United States

ARTICLE INFO

Article history:
Received 20 July 2013
Received in revised form 18 August 2014
Accepted 3 September 2014
Available online 2 October 2014

Keywords:
Optimal regulation
Limited transfers
Dynamic regulation

ABSTRACT

We consider a two period model of optimal regulation of a firm subject to marginal compliance cost shocks. The regulator faces an asymmetric information problem: the firm knows current compliance costs, but the regulator does not. Both the regulator and the firm are uncertain about future costs. In our basic framework, the regulator may not offer payments to the firm; we show that the regulator can vary the strength of regulation over time to induce the firm to reveal its costs and increase welfare. In the optimal mechanism, the regulator offers stronger (weaker) regulation in the first period and weaker (stronger) regulation in the second period if the firm reports low (high) compliance costs in the first period. Low cost firms expect compliance costs to rise in the future, and thus prefer weaker regulation in the second period. High cost firms expect costs to fall in the future and thus prefer regulation which becomes stricter over time. Thus the regulator offers the low (high) cost firms *slightly* weaker (stronger) regulation in the second period in exchange for *much* stronger (weaker) regulation in the first period, thereby "timing" the regulation. If the regulator can make payments, then the optimal mechanism to some degree times the regulation as long as a positive marginal cost of funds exists. If the marginal cost of funds is high enough, then under the optimal mechanism the regulator will not use payments and use our timing mechanism exclusively.

1. Introduction

We consider a two period model of optimal regulation of a firm subject to marginal compliance cost shocks. The regulator faces an asymmetric information problem: the firm knows the current compliance cost, but the regulator does not. Both the regulator and the firm are uncertain about future compliance costs. Standard economic theory suggests making payments or rebates conditional on the benefits or costs of regulation. Frequently, however, regulators are unable to make monetary payments to firms. Regulators do typically have considerable latitude on how regulations are implemented: they may interpret vague statutes weakly or strictly, grant waivers to delay implementation of the regulation, shape future legislation so that regulations become more strict or weak, and/or vary enforcement. We show that the regulator can vary the strength of regulation over time to induce the firm to reveal the cost of compliance and increase welfare by explicitly characterizing the optimal regulatory policy.

In the optimal mechanism the regulator offers stronger regulation in the current period and weaker regulation in the next period if a firm reports low compliance costs in the current period. Conversely, firms reporting high costs receive regulation that becomes stronger over time. We refer our mechanism as "timing" the regulation. At first glance, timing the regulation may seem counterintuitive. Since compliance costs are convex, a policy that strengthens regulation in the current period and weakens regulation in the next period by an equal amount is more costly than an average level of regulation in both periods. However, the regulator need only offer slightly weaker regulation in the future in exchange for much stronger regulation today to induce the low cost firms to reveal their type. This is because a firm that receives a below average compliance cost shock in the current period expects higher costs in the next period. Thus, low cost firms prefer to be regulated lightly in the future, and so the regulator need only offer slightly weaker future regulation to induce the low cost firms to reveal their types today. Similarly, firms receiving a higher than average cost shock expect costs to fall over time, and thus prefer regulation that is initially weaker. As will be clear in the paper, timing the regulation not only improves welfare by making regulation stronger when compliance costs are low, but also improves welfare by inducing firms to reveal cost shocks.

A large literature develops mechanisms that induce firms to reveal compliance cost shocks and raise welfare. Standard economic theory

☆ We would like to thank Kai Konrad, two anonymous referees, Juan-Pablo Montero, seminar participants at the University of Arizona, the 2011 Association for Environmental and Resource Economics Summer Conference, the National Bureau of Economic Research Summer Institute, and the University of Miami for helpful comments and suggestions. The working paper version of this paper circulated with the title "Dynamic Regulation Design Without Payments: Timing is Everything."

* Corresponding author.
E-mail addresses: r.boleslavsky@miami.edu (R. Boleslavsky), dkelly@miami.edu (D.L. Kelly).

http://dx.doi.org/10.1016/j.jpubeco.2014.09.008
0047-2727/

(see for example, Roberts and Spence, 1976; Kwerel, 1977) suggests the first best (full information) level of regulation may be achieved in competitive environments via hybrid tax/subsidy or permit/subsidy mechanisms. These mechanisms, however, require firms to be competitive price takers. Dasgupta et al., 1980; Kim and Chang, 1993; Montero, 2008, and Spulber (1988) consider regulation of potentially non-competitive firms via tax/subsidy or permit/subsidy mechanisms. For example, Montero, (2008) proposes an elegant first best mechanism whereby firms first bid for permits via a uniform-price sealed-bid auction. The regulator then rebates a fraction of the auction revenue to the firm conditional on the residual marginal benefit of regulating each firm. In this way, the benefits of regulation are transferred to the firm, and the firm's problem becomes identical to the regulator's. Firms then optimally choose the first best (full information) level of regulation as a dominant strategy.[1]

The degree to which each of these mechanisms is used, or could be used, in practice varies. Mechanisms that rely on perfect competition rule out a host of highly regulated industries, such as electricity. Similarly, firms are not typically asked to report each other's costs since cost information is likely private (Wiggins and Libecap, 1985). The mechanism proposed by Montero (2008) is consistent with some regulations.[2]

Nearly all mechanisms characterized in this literature require monetary transfers between the regulator and firm (typically the regulator extracts payments from the firm, which are then rebated back to the firm).[3] If the regulator has access to a revenue stream and legal authority to make payments from that revenue stream, then such payments are plausible. For example, sulfur dioxide permit auction revenue provides a funding source and the EPA has the authority to design an auction with a rebate. Mason and Plantinga (2013) also propose a plausible mechanism whereby payments for carbon offsets are subject to a "claw-back," which allows the regulator to revoke some payments ex post.[4]

Most regulatory environments (examples include all command-and-control regulation and permit based regulation in which permits are grandfathered or otherwise freely allocated) do not feature payments from the firm to the regulator, nor monetary subsidies to firms that report low compliance costs. Instead, regulators typically have considerable discretion over the interpretation of vague statutes, enforcement of existing regulations, the granting of waivers,[5] and other decisions affecting the strength of regulation. For example, "New Source Review" regulation requires that, with the exception of "routine maintenance," modifications to a plant which cause a "significant increase" in a regulated pollutant receive an EPA review that typically forces the plant to adopt the best available pollution control technology. Both "routine maintenance" and "significant increase" are terms that are not precisely defined, and indeed interpretations of this statute by the EPA have varied over time (Stavins, 2006, footnote 90). While New Source Review and similar command and control regulations do not give the regulator discretion to set up a permit or tax/subsidy mechanism, our results show that the regulator can improve welfare by timing the regulation: offering firms a choice of regulations that become either stronger or weaker over time.

Although our paper is theoretical, in practice regulators sometimes implement dynamic regulations that resemble our mechanism, allowing firms a choice of regulation that either becomes stronger or weaker over time. Joskow and Schmalensee (1998) provide a detailed examination of the rules of the sulfur dioxide permit trading system created by the 1990 Clean Air Act. One provision gives utilities that install scrubbers future "bonus" permit allocations. Firms that install scrubbers clearly face more costly regulation up front, but are rewarded with weaker regulation in the future, since (at a minimum) their allocation of permits rises over time. Conversely, by declining the option, firms save the initial cost of scrubbers, but do not gain bonus permits later. Thus declining the option results in regulation which becomes stronger over time.[6] Section 6 discusses additional practical examples.

Even if the regulatory framework allows for payments to and from the firm, the absence of lump sum taxes implies payments to the firm could instead be used to reduce labor or other distortionary taxes (Bovenberg and Goulder, 1996). Thus, a regulator using payments faces a tradeoff between information revelation and the distortionary cost of government funds (Montero, 2008). Therefore, with a distortionary cost of funds, payment-based mechanisms no longer achieve the first best. Our mechanism, which trades off current and future distortions, also does not achieve the first best. Nonetheless, we show that with any positive marginal cost of funds, the optimal regulation involves some degree of timing, even when payments are available. Further, we show that for marginal costs of funds above a threshold, characterized explicitly in Proposition 4, the regulator uses the timing mechanism exclusively.[7]

The timing mechanism takes advantage of firm uncertainty over the realization of future cost shocks. Many authors consider regulation with time varying compliance cost shocks, which fit naturally into our framework. Newell and Pizer (2003) and Karp and Zhang (2005) consider pollution regulation with time varying abatement cost shocks. Heutel (2012); Fischer and Springborn (2011) consider climate change regulation when firms experience autoregressive productivity shocks. Productivity shocks fit naturally into our framework since firms know current, but not future, shocks. Other natural interpretations of time-varying compliance costs include input prices which vary randomly over time and the uncertain discovery of cost saving innovations. Section 4 extends our mechanism to general cost-shock processes, allowing for costs that are correlated over time, such as productivity shocks.

Our mechanism relies on commitment: the ability of the regulator to commit to weak (strong) regulation in the future for firms that report low (high) costs today.[8] A number of papers (e.g. Freixas et al., 1985; Yao, 1988) study models in which marginal costs are fixed and not subject to shocks. In this case, the regulator who learns a firm has permanently low costs has an incentive to renege on a commitment to weak regulation and instead impose the optimal regulation given the known low compliance costs in the second period (the "ratchet effect"). In contrast, the incentive to renege is relatively minor in our mechanism. If costs are i.i.d. over time, then the regulator who learns the firm has low costs in period one has only prior information about the firm's costs in period two. The regulator thus does not desire to ratchet the second period regulation up to the optimal level for a firm known to

[1] Other mechanisms (Varian, 1994; Duggan and Roberts, 2002) rely on the assumption that firms know each other's marginal costs. Given this unlikely assumption, however, the regulator can simply require firm's to report all other firm's costs, and punish firms if the results do not agree (Cremer and McLean, 1988).

[2] NO_x permit allocations in Sweden have a rebate based on market share (Gersbach and Requae, 2004). In the US, the EPA holds back 2.8% of grandfathered SO_2 allowances from firms, and then auctions them, rebating the revenue back to the firms (Joskow and Schmalensee, 1998).

[3] The exceptions are those mechanisms requiring firms to know and report each other's costs. The mechanism of Kwerel (1977) does not use payments to the firm in equilibrium.

[4] A legislator may have the freedom to design a bill with a payment of an initial allocation of permits. The allocation would have to be tied to the residual marginal benefits of regulating each firm, however.

[5] The provision of the Patient Protection and Affordable Care Act phasing out annual payment limits has been temporarily waived for 729 companies (Department of Health and Human Services, 2011).

[6] The Clean Air Act allows pollution permit "banking" (Ellerman and Montero, 2007), which also gives firms some control over the strength of regulation over time. However, we show in Section 2 that our timing mechanism yields higher welfare than permit banking, since the timing mechanism induces firms to reveal cost shocks, while banking does not.

[7] Our result should not be confused with the dynamic moral hazard literature, in which it is optimal for the principal to use both payments and continuation values to reward agents. Here, the gains to the principal from using the continuation value as compensation are not driven by "payment smoothing." In our mechanism, payments in the form of weaker regulation are not perfect substitutes across time to the agent, which the principal exploits to gain information.

[8] All permit-subsidy schemes require commitment at some level, since otherwise the regulator would renege on the subsidy.