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Discretionary Exemptions from Environmental Regulation: Flexibility for Good or for Ill

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Abstract

We develop a model of firm and regulator behavior to examine theoretically the use and consequences of discretionary exemptions (also known as variances, waivers, or exceptions) in environmental regulation. Many environmental protection laws, such as the Clean Water Act, impose limits on harmful activities yet include “safety valve” provisions giving the regulator discretion to grant full or partial exemptions that provide permanent or temporary relief from these limits. This discretion begets flexibility over the stringency of environmental protection laws. Our model places a profit-maximizing discharger of pollution under the purview of a fully informed regulator who may seek to maximize social welfare by imposing limits. We show that when a regulation does not otherwise allow flexibility, an exemption that relaxes the limit for firms with high abatement costs can improve social welfare by reducing the costs of achieving the given level of environmental quality. We further demonstrate that if the effectiveness of abatement technology improves over time, a temporary exemption can increase social welfare by adjusting allowable pollution in response to these dynamic conditions. We also show that if the labor market is sticky, exemptions can benefit workers. Driven by an unequally weighted social welfare function, the regulator may use exemptions to meet redistributive ends. However, these beneficial impacts of exemptions rely on a fully informed and benevolent regulator; otherwise, the discretionary nature of exemptions leaves them open to abuse. A regulator who is captured by industry, focused only on her own jurisdiction or answerable only to a set of elites, can abuse exemptions in ways that reduce social welfare, such as allowing inefficiently high pollution or inducing a cost-ineffective pattern of abatement.

JEL codes: D21, D62, K32, Q52, Q53, Q58

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Contents

1. Introduction

Environmental protection laws impose strict limits on harmful activities, yet many include “safety valve” provisions giving regulators the discretion to grant exemptions that relax in whole or in part the requirements on some regulated parties. Discretionary exemptions, also known as waivers, variances, or exceptions, can be permanent or temporary and vary in the degree of justification required by the regulator of the regulated entities. For example, in the United States, the Clean Water Act requires permit writers to impose limits based on local water quality conditions whenever these limits are tighter than sector-specific standards. However, the Clean Water Act also allows regulated wastewater dischargers to petition for a temporary exemption from these tighter water quality–based limits. The US Environmental Protection Agency (EPA) has the discretion to grant exemptions when compliance with these tighter limits is expected to cause “substantial and widespread impacts” in the affected community.[1] As another US example, the Endangered Species Act imposes stringent restrictions on landowners’ use of land parcels on which endangered species are present, but the act offers EPA discretion to grant permanent exemptions when certain conditions are met. And as the most commonplace example, zoning codes restrict landowners’ use of land parcels in myriad ways, but local governments frequently exploit their discretion to issue exemptions when landowners petition for relief from those rules, such as for use of agriculturally zoned land for commercial purposes.

Despite the prevalence of exemptions in environmental policy, we are unaware of previous studies exploring the relationship between discretionary exemptions from environmental regulations and social welfare from an economic perspective. We seek to fill this void by crafting a theoretical model of firm and regulator behavior to examine the use and welfare consequences of regulatory exemptions. Our model places a profit-maximizing discharger of pollution under the purview of an omniscient regulator who may seek to maximize social welfare reflecting the surplus accruing to the owners of regulated firms, household utility derived from consumption and input provision (e.g., labor), and environmental damages caused by pollution. Using this model, we seek to answer this question: What are the welfare consequences of discretionary exemptions from environmental regulations?

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[1] Clean Water Act 40 C.F.R. §131.14, 2015.

We first construct a model with idealized conditions: (1) symmetric information between the regulator and regulated firms, and (2) a regulator who seeks to maximize social welfare. Given these congenial conditions, the result is unsurprising: if the regulator's standard policy is inflexible, then an exemption from that policy can improve social welfare by providing the regulator with flexibility to allow for a more cost-effective outcome. We suggest, but do not prove, that firms could exploit an information asymmetry to render exemptions less socially productive. We next explore the role of temporary exemptions when policy tools are static and abatement technology exogenously improves over time. Again, we find social welfare gains from exemptions, though if this technological improvement is endogenous, we suggest that exemptions may disrupt technological growth. We then consider a regulator's use of an unequally weighted social welfare function. In this context, we show that the regulator could use exemptions for redistributive ends when the weights reflect normative values or to benefit a narrow constituency if the weights may reflect regulatory capture. In the latter case, the use of exemptions is a benefit to some subset of society but a detriment to society in general.

2. Literature Review

Surprisingly little research analyzes the economics of exemptions. The closest study to our analysis is Kaplow (2017), which theoretically explores the question of when the exemption of small firms from regulations might be efficient. Kaplow ranks producers along a continuum based on a parameter that determines the slope of their marginal cost curve. Firms that produce less than a threshold are exempted from the regulation. The exemption of small firms (i.e., firms with high marginal costs) decreases their marginal costs, leading them to increase their output and pollution. The exemption also creates an incentive for some firms with optimal unregulated production above the threshold to reduce their production to this threshold in order to avoid the regulation. Despite this distortionary incentive, Kaplow demonstrates that exemptions can generate benefits that exceed costs, which would justify exemptions on the grounds of economic efficiency. While Kaplow looks at the use of a regulatory exemption, this policy tool is not discretionary in the way that the exemptions we study are; as we describe in the next section, many exemptions issued in environmental regulation, as well as other regulatory areas, are discretionary.

In contrast to the minimal literature on discretionary exemptions, an extensive literature examines how regulatory flexibility in a general sense can increase welfare. Seminal articles on incentive-based mechanisms, such as emissions charges and cap-and-trade schemes, reveal that flexibility granted to regulated entities improves cost-effectiveness relative to performance-based standards (e.g., Montgomery 1972). Similarly, performance-based standards grant greater flexibility than design-based standards (Field and Field 2017; Goulder and Parry 2008). Despite increased interest in using incentive-based mechanisms, inflexible command-and-control policies remain common in environmental regulation (Hahn 2000; Stavins 2007), such that exemptions can and do play an important role in influencing welfare outcomes.

Another related literature explores regulatory choices when regulatory agencies possess meaningful discretion over their choices. For example, environmental policy grants a significant amount of discretion to inspectors and enforcement personnel when monitoring and enforcing regulatory restrictions, such as pollution limits. Studies in this area include Deily and Gray (1991), Earnhart (2004b; 2016), and Kang and Silveira (2018). Regulatory discretion can be particularly troublesome in cases of regulatory capture (Raff and Earnhart 2018), wherein firms prod the regulator for less strict enforcement (Maloney and McCormick 1982). Environmental federalism offers another way for agencies to exercise regulatory discretion by delegating regulatory decisions to decentralized authorities (e.g., Arguedas et al. 2017; Banzhaf and Chupp

2012). The main difference between environmental federalism and our study's focus is that we consider the granting of flexibility on a polluter-by-polluter basis, whereas environmental federalism allows for variation of regulation across geographic space. Additionally, studies of environmental federalism assume that subnational regulators possess detailed information about regulated entities and locational parameters (e.g., local environmental quality); accordingly, these subnational regulators can tailor their regulations to entity- or location-specific features, while higher-level regulators cannot. Our study of exemptions does not rely on this informational asymmetry.

3. Regulatory Context in the United States

Discretionary exemptions are a pervasive feature of regulatory policy in the United States. Government entities have used them in macroeconomic policies (e.g., import tariffs; Swanson and Hsu 2018); social policy (e.g., the criminal justice system; Oliss 1994); and even in national defense (e.g., Vietnam draft deferments; Schick 1975). Our study focuses on the use of such exemptions in environmental policy.

There are many examples of the use of discretionary exemptions in US environmental policy.[2] These examples include temporary waivers for fuel content regulations under the 2005 Energy Policy Act in cases where the rules would impose "disproportionate economic hardship" (Aldy 2017); rare but high-profile permanent exemptions from the stringent regulations imposed by the Endangered Species Act on parcels of land inhabited by endangered species (Yuknis 2011); and temporary exemptions from the Renewable Fuel Standard (RFS) (EPA 2017). In the first case, Aldy (2017) argues that a discretionary (rather than rule-based) waiver system can reduce social costs by responding flexibly to short-term economic disruptions when the standard is otherwise relatively inflexible.

The most common exemptions related to environmental policy are almost certainly local zoning variances. Zoning codes restrict landowners' use of parcels in myriad ways. Local (municipal) governments establish zoning codes that specify, among other things, the allowable use of a parcel (e.g., residential, commercial, or agricultural). These codes consequentially influence the development of zoned areas (Levkovich et al. 2018; Shertzer et al. 2018). Local governments also use zoning for other purposes affect environmental quality, such as limiting deforestation (Nolte et al. 2017), banning hydraulic fracturing (Hall et al. 2018), limiting housing density (Zhang et al. 2017), and specifying a minimum setback of construction from a waterway. Local governments that specify zoning regulations receive applications for and grant, at their discretion, variances from these regulations.

While zoning variances have received little attention in the economics literature, Twinam (2018) finds that variances in Seattle were more common in cases where the initial zoning codes were relatively inflexible. In legal studies, zoning variances have a

[2] Agencies can also use exemptions to impose *more* stringent regulation, as with the 2009 California Clean Car regulations, designed to reduce emissions from vehicles (**https://www.arb.ca.gov/cc/ccms/ccms.htm**).

dual reputation. By providing regulatory relief in situations where it is deemed practical and fair to do so, zoning variances can provide flexibility to enhance social welfare and allow landowners reasonable use of their property (Cohen 1994). However, variances' discretionary nature leaves them open to abuse (Owens 2004). To be sure, most zoning authorities apply a standard when deciding whether to grant a variance. However, given the simplicity of most zoning rules, relative to the complexity of the zoned landscape, surely human judgment inevitably enters into variance decisions. Rather than serve as a safety valve for exceptional cases, variances may be used as commonplace tools for circumventing rules meant to protect social welfare; indeed, the approval rate for variances ranges between 58 and 90 percent, according to studies reviewed by Owens (2004). That said, the ability to grant variances may allow zoning authorities to set broader and more stringent zoning rules than would be the case if zoning restrictions applied uniformly across land parcels.

Another example to which we return often in this study is the Clean Water Act, which requires writers of discharge permits (regulators) to impose limits based on local water quality conditions whenever these limits would be tighter than sector-specific standards, known as Effluent Limitation Guidelines (Earnhart 2007). In other words, a national standard sets the maximum wastewater discharge limits. However, permit writers can and frequently do impose limits tighter than the discharge standard with the goal of preserving water quality so that a waterway can support the type of use (e.g., fishable/swimmable) designated by the relevant state agency. States base this designation not on cost-benefit analysis, but on the goal of rendering waters fishable and swimmable wherever that is achievable. At the same time, the Clean Water Act allows regulated wastewater dischargers to petition for a temporary variance from these tighter water quality–based limits when compliance with these tighter limits is expected to cause "substantial and widespread economic and social impacts" in the affected communities.

As with the zoning case, EPA grants Clean Water Act variances based primarily on applications from affected parties. In certain cases, state agencies may themselves prepare multidischarger variance application packages on behalf of a group of dischargers facing similarly steep abatement costs (EPA 2013). If granted, the variance allows regulated polluters to "press the pause button" until conditions facilitate compliance without problematic impacts. For example, a community may be unable to upgrade its wastewater treatment plant to comply with a water quality standard during an economic recession, but it may anticipate less difficulty in the near future when household incomes recover. In this case, compliance in the near term might be judged to impose a substantial and widespread impact, but not once the economy recovers.

Clean Water Act variances differ from zoning variances in several important ways. First, Clean Water Act variances are temporary, whereas zoning variances are permanent. Second, a zoning rule is chosen by local planners with the ostensible goal of optimizing local land use, given that some variances will be granted. On the other hand, permit writers set discharge limits under the Clean Water Act so that the waterway supports its designated use; variances are merely meant to address short-term bumps in the road toward achieving the level of ambient water quality associated with the designated use. Put differently, EPA does not seek to maximize social welfare when identifying the discharge limit needed to support the designated use and the ability to grant a variance does not alter the relevant water quality–based discharge limit. Our theoretical model incorporates cases in which the initial standard is optimally set with the understanding that the regulator may grant exemptions (reflecting two-step backward induction), as well as cases in which the initial standard is inflexible, offering no opportunity for a priori optimization given the existence of variances. The implications for environmental impacts differ greatly between these cases. Finally, the Clean Water Act and zoning variance cases also differ in the types of institutions with authority to issue variances. While we do not take a stand on how best to represent either case, our model explores both institutions that maximize equally weighted social welfare and institutions that pursue other objectives, including redistribution or objectives shaped by manipulative forces such as political machinations and rent-seeking.

4. Basic Model

Our model includes three types of agents: (1) firms that sell products and generate pollution; (2) households that buy products, sell inputs (e.g., labor), and bear the consequences of pollution generated by firms; and (3) a regulator who legally constrains firms' pollution levels. The regulator may or may not seek to maximize social welfare. The regulator's tools are (a) a limit on pollution, which we refer to as the *baseline discharge limit*, and (b) an exemption that the regulator may grant on an idiosyncratic basis to firms. This exemption allows the firm to meet a limit that is less stringent than the baseline discharge limit on a permanent or temporary basis. While the word *exemption* is often used as a discrete choice variable—that is, complete dispensation from a regulation—we allow exemptions to include situations in which the regulator requires the firm to partially adhere to the regulation, meeting a less stringent limit.

4.1. Model Foundations

The J firms produce a variety of products and generate a single kind of pollution. We assume that quantities of inputs, outputs, and pollutant discharges are continuous variables. The firms' problems are well behaved: the firms' marginal cost of production curves are upward sloping, their input demand curves are downward sloping, and their marginal abatement cost curves are upward sloping. Constrained by its production technology, firm j chooses its vector of product quantities, denoted $\boldsymbol{q}_j$ (all final goods marketed to consumers), and its level of pollutant discharges, denoted E_j. The firms face a vector of output prices, denoted $\boldsymbol{p}$, and a vector of input prices, denoted $\boldsymbol{w}$, where the first input (with price w_0) is labor. Each firm operates as a price taker in product and input markets. While social welfare functions typically do not consider firms, we assume that each firm's surplus accrues to a single risk-neutral owner so that changes in the firm's profits map directly to changes in welfare.

All input and output markets equilibrate. We do not allow entry of new firms; therefore, in our model, firms can earn positive profits in their competitive markets. This condition is equivalent to assuming that the fixed costs of entry exceed the present value of profits.

Each firm faces a baseline discharge limit, denoted as R_j, imposed by the regulator. If a firm exceeds its baseline discharge limit, it pays a penalty. We assume that the penalty is sufficiently high and unavoidable to ensure that no firm exceeds its limit. Since each firm's marginal abatement cost curve is upward sloping, no firm pollutes less than its limit; thus its discharge level equals the limit: $E_j = R_j$.[3]

Each firm is privately owned and makes input, output, and discharge decisions to maximize its private profits. We let $\pi_j(\boldsymbol{p}, \boldsymbol{w}, R_j)$ represent the profit function for firm *j* that reflects these optimal decisions. Since abatement is costly, each firm's profits rise as its discharge limit becomes less stringent: $\partial\pi_j(\cdot)/\partial R_j > 0$. Since production and abatement cost structures vary across firms, the optimized profit functions also vary across firms.

Each household *i* transacts with the firms to buy goods at prices $\boldsymbol{p}$ and to sell labor at wage rate w_0. The household holds risk-neutral preferences. In addition to wage income, this household enjoys exogenous endowment income, m_i. We thus write the household's indirect utility function as a function of prices and endowment income: $V_i(\boldsymbol{p}, \boldsymbol{w}, m_i)$. We assume that household *i* is a unitary entity that makes choices to maximize some well-behaved utility function. We also assume that V_i is linear in m_i so there are no income effects. Thus we can express $V_i(\cdot)$ in monetary units without loss of generality.

Household *i*'s welfare also depends on environmental damage caused by pollution. In our basic model, we assume that pollution is uniformly dispersed, which implies that each household experiences damages as a function of the level of aggregate pollution, denoted as $E = \sum_j E_j$. (Section 5 relaxes the assumption of uniform mixing.) Household *i* experiences environmental damages, denoted as $D_i(E)$, with $\partial D_i/\partial E > 0$, which we treat as additively separable from $V_i(\cdot)$. Aggregating across households, we write total environmental damages as $D(E) = \sum_i D_i(E)$. As with indirect utility, we express environmental damages in monetary units.

We consider first a regulator who seeks to maximize a social welfare function, denoted as *W*, that depends on firm profits, household indirect utility, and environmental damages:

$$W = \sum_j \pi_j(\boldsymbol{p}, \boldsymbol{w}, R_j) + \sum_i \big(V_i(\boldsymbol{p}, \boldsymbol{w}, m) - D_i(E)\big). \quad (1)$$

[3] We model discharges as a deterministic outcome. In reality, discharges stem from a stochastic process. This uncertainty may cause polluters to choose to overcomply with discharge limits (Beavis and Walker 1983a, b).

Since the regulator maximizes social welfare, the regulator's choices are tautologically social welfare maximizing. In the social welfare function depicted in (1), the weights placed on firms and households are implicitly equal. Section 5 explores the case where the regulator maximizes an optimand other than an equally weighted social welfare function.

As discussed above, institutional constraints may force the regulator to impose a uniform baseline discharge limit on all polluters. Suppose the regulator faces the requirement to impose a limit no higher than some legal upper bound or to impose a uniform baseline discharge limit $\bar{R}$. We refer to $\bar{R}$ as the *discharge standard*. When exploring a single firm, we model the discharge standard as a legal upper bound. This arrangement mirrors the case of the Clean Water Act, in which the regulator can set a limit tighter, but not looser, than the standard for a sector, and exemptions always relax water quality–based limits. When exploring multiple firms, we model this standard as a uniform baseline; in this case, the standard does not constrain the regulator's choice of the limit level, but exemptions still always relax limits.

In this context, we define an exemption as the granting of an exception from the discharge standard that allows one or more firms to emit more than $\bar{R}$. We assume that the regulator has full knowledge of the firms' and households' objective functions and can issue an exemption costlessly. In this basic model, we assume the regulator chooses whether and to which firm or firms to issue an exemption to maximize social welfare.

We consider two degrees of constraint that the regulator may face. In one case, the regulator is not able to choose $\bar{R}$; such a limitation may stem from having to apply a formula or heuristic or from being subject to constrained optimal planning. In this case, the ability to issue exemptions is the only discretion available to the regulator. This arrangement reflects the Clean Water Act context in which limits ultimately derive not from cost-benefit analysis, but from sector-wide standards and the goal of having waterways support designated uses (e.g., fishable/swimmable). In the second case, the regulator chooses $\bar{R}$ as a constrained optimum, so the ability to issue exemptions materially changes the chosen baseline discharge standard. This arrangement reflects a zoning context in which a local government imposes a tight standard, such as a minimum setback for construction, because the regulator knows that exemptions may only loosen the requirement. In the first case, the regulator makes only one optimizing decision (choosing the exemption), whereas in the second case, the optimization process involves two stages (choosing the standard and exemption(s)), which may or may not take place simultaneously.

4.2. Basic Model 1: Input and Output Prices Are Not Affected by Discharge Limits

We first assume that exemptions (or, more generally, changes in limits) do not affect input or output markets, so household indirect utility, $V_i(\boldsymbol{p}, \boldsymbol{w}, m_i)$, is unaffected. In Section 4.3, we obtain similar results from a model that allows exemptions to affect wage rates.

4.2.1. Single Firm

We first consider the simple context in which only a single regulated firm operates. The regulator first chooses a baseline discharge limit, R_j, for the firm, and the firm complies, setting $E_j = R_j$. Since the baseline discharge limit does not affect any household's indirect utility, the optimal level for R_j, denoted as R_j^*, sets the marginal benefits of greater discharges equal to the marginal costs of greater environmental damages:

$$\frac{\partial \pi_j\left(\boldsymbol{p}, \boldsymbol{w}, R_j^*\right)}{\partial R_j} = \frac{\partial D\left(R_j^*\right)}{\partial E}. \qquad (2)$$

The discharge standard, $\bar{R}$, may constrain the regulator's optimal choice. If $\bar{R} \geq R_j^*$, then the regulator can impose an optimal baseline discharge limit at the level R_j^*. However, if $\bar{R} < R_j^*$, the regulator is not able to set the baseline discharge limit at the optimal firm-specific level. In this case, when evaluated at $\bar{R}$, the left side of equation (2) is greater than the right, implying social gains from relaxing the firm's discharge limit. Therefore, the regulator could improve social welfare by issuing an exemption; optimally, the regulator would choose an exemption that allows the firm to pollute up to the level R_j^*. In this case, the discretion to grant an exemption is a tool for regulatory flexibility that is efficiency enhancing.

This result is not particularly surprising: if the benefits of an exemption exceed the costs, then the exemption increases societal net benefits. When compared with existing policy, however, environmental agencies rarely carry out such calculations even implicitly. For example, implementation of the Clean Water Act offers little consideration of the impact of an exemption on environmental damages (EPA 1995). In this case, exemptions are not necessarily socially optimal.

To achieve an optimal exemption, the regulator needs full knowledge of the firm's cost structure. In a world of asymmetric information, the firm has an incentive to overstate its costs to the regulator (Kwerel 1977). Overstating costs to increase the likelihood of an exemption is only one avenue for misrepresentation to improve a regulated firm's position. Since the regulator can expect this misrepresentation, the regulator should be leery of issuing exemptions.

We do not explicitly model asymmetric information because a robust literature reveals the downside of this feature: incomplete information undermines welfare (Boleslavsky and Kelly 2014). Dasgupta et al. (1980) and Spulber (1988) offer early analyses on the effect of imperfect information on optimal pollution control. More recent studies explore particular features; as examples, Lewis (1996) examines privately known benefits rather than simply costs, Antelo and Loureiro (2009) consider the role of signaling, and Boleslavsky and Kelly (2014) look at the timing of firms' revelation of private information.

4.2.2. Multiple Firms

We now extend the basic model to consider multiple firms. As in the case of a single firm, the welfare-maximizing baseline discharge limits, R_j, would be set where the marginal benefits of greater pollution equal the marginal costs of greater environmental damages for each firm *j*:

$$\frac{\partial \pi_j\left(\boldsymbol{p},\boldsymbol{w},R_j^*\right)}{\partial R_j} = \frac{\partial D(E^*)}{\partial E} \quad \forall j. \tag{3}$$

In general, the first-best baseline discharge limit, R_j^*, differs across firms.

However, institutional constraints may force the regulator to impose a single uniform discharge standard on all regulated firms, $\bar{R}$. As noted earlier, this standard need not stem from efficiency concerns but could instead arise from some heuristic. However, it is possible for the choice of uniform standard to account for aggregate benefits and costs. In the presence of a uniform standard, aggregate discharges equal the sum of the *J* individual firms' discharges, $E = J \cdot \bar{R}$. The second-best or constrained welfare-maximizing uniform discharge standard, denoted as $\bar{R}^*$, satisfies the following equation:

$$\sum_j \frac{\partial \pi_j(\boldsymbol{p},\boldsymbol{w},\bar{R}^*)}{\partial R_j} = J\,\frac{\partial D(J \cdot \bar{R}^*)}{\partial E}. \tag{4}$$

Compared with the socially optimal policy shown in equation (3), if the firms' marginal cost curves differ and $D(\cdot)$ is upward sloping, the optimal uniform standard policy leads to more pollution than the socially optimal level, $J\bar{R}^* > \sum R_j^*$, because the costs of meeting any standard are higher when all firms must abate equally regardless of abatement cost. At the same time, it is not cost-effective, because the firms' marginal costs at $\bar{R}^*$ differ, so equimarginality must be violated.

If a regulator is able to grant exemptions, this ability offers the potential to improve societal welfare relative to that achieved with use of only the uniform standard, $\bar{R}^*$. We first consider the case of offering an exemption to only one firm. Holding discharge limits equal to $\bar{R}^*$ for all but one of the *J* firms, a marginal exemption that increases the discharge limit for the *j*th firm improves social welfare under the following condition:

$$\frac{\partial \pi_j(\boldsymbol{p}, \boldsymbol{w}, \bar{R}^*)}{\partial R_j} - \frac{\partial D(J \cdot \bar{R}^*)}{\partial E} > 0. \quad (5)$$

The first component of equation (5) represents the marginal increase in the *j*th firm's profits due to greater discharges, while the second component represents the marginal increase in the social costs of environmental damages. If the former dominates, social welfare increases as a result of issuing this marginal exemption. A nonmarginal exemption similarly increases welfare if the total abatement cost savings from the exemption are greater than the total damages associated with the increase in pollution precipitated by the exemption.

If the regulator cannot change the standard applied to other firms, as in the Clean Water Act context, the aggregate level of pollution rises above the level targeted by the initial standard. However, if the regulator sets the standard applied to other firms based on the knowledge that an exemption may be granted, as in the zoning context, then the revised standard for other firms is lower than $\bar{R}^*$ because marginal damages are increasing. Thus pollution shifts from the firms without the exemption to the firm with the exemption. In other words, when the regulator chooses to issue an exemption to firm *j*, she should simultaneously choose a new, tighter standard that applies to all other firms.

If the regulator is able to choose which of the *J* firms (if any) receive the lone exemption, then the highest social gains stem from granting the exemption to the firm that has the highest potential increase in profit. This is the firm facing the highest marginal abatement cost. Thus, if we order firms by abatement costs from lowest to highest, the regulator grants the exemption to firm *J*. If the regulator grants a nonmarginal exemption to firm *J*, then $R_J > \bar{R}^*$, and $\bar{R}^*$ (which is determined in the absence of exemptions) is no longer second best for the remaining $J - 1$ firms. By the same logic as in the marginal exemption case, if the regulator is able to optimize the standard, the ability to issue an exemption leads to a tighter standard on other firms.

What is the effect on aggregate pollution of an exemption that is accompanied by an optimal adjustment in the uniform limit? If the uniform standard that applies to other firms does not change, then pollution must increase, and if pollution costs are convex as assumed, then marginal damages increase. If the exemption is optimal and is accompanied by an optimal adjustment in the uniform standard for the remaining firms, then the marginal abatement costs decline because abatement is shifted from high-cost to low-cost firms, and as a result, the total level of discharges falls. This is one of the strongest cases in which exemptions can be a force for good. If regulators grant exemptions to firms with high abatement costs and anticipate such exemptions when setting the standard for the remaining firms, then both pollution and abatement costs can be reduced.

If the regulator is able to grant exemptions to *all* firms, then she can implement the first-best policy by customizing each firm's limit to its optimum. In this case, the exemptions, combined with the regulator's perfect knowledge of firms' costs, result in the exact pollution allocation identified by equation (3). In theory, therefore, the regulator can use her discretion to generate flexibility that yields perfect cost-effectiveness.

Usually, however, the regulator can grant exemptions only to some but not all firms. If she has the capacity to grant only $K < J$ exemptions, then the optimal set of firms to receive exemptions is the *K* firms with the highest marginal abatement costs, and the $J - K$ lowest-cost firms continue to be regulated under the uniform standard. The regulator can achieve the greatest increase in cost-effectiveness if she can tailor the exemptions so that each firm that receives an exemption faces an individualized optimal limit. The regulator can still achieve cost reductions if she can issue exemptions only through one common looser discharge limit. In this case, the regulator assigns firms 1 through $J - K$ the tighter discharge standard, which falls within the range of first-best limits for those firms, and assigns the remaining *K* firms the common looser exemption discharge limit, which falls within the range of first-best limits for those firms.

As in the single-firm context, exemptions in the setting of multiple firms offer the potential to improve societal net benefits. However, the same caveats noted above apply: the regulator must aim to maximize social welfare by assessing costs and benefits and must possess full information. If either condition fails to apply, exemptions could reduce net benefits.

4.2.3. Improvements in Abatement Technology over Time

We next relax the assumption of static conditions regarding production and abatement cost structures and consider a case in which an exogenous factor improves firms' abatement abilities over time. These kinds of improvements are relevant to the use of exemptions in the Clean Water Act context, in which a water quality standards variance provides temporary relaxation of a discharge limit because abatement costs are expected to fall enough over time that the regulation will eventually cease to generate "substantial and widespread socioeconomic impacts."[4] EPA (2013) specifically lists the development of less expensive pollution control technology as a valid reason for states and tribes to adopt a water quality standards variance. Modeling the role of exemptions in this context requires movement from a static to a dynamic setting. To simplify matters, we retain the assumption that pollution is uniformly mixed and also assume that it is instantly assimilated, so that pollution damages in a given time period t, D_t, are driven only by discharges in that period, E_t.

Suppose the cost to firm *j* of achieving any given level of abatement decreases over time at an exogenously determined rate over T time periods. As a result, the firm's profit function changes over time. We represent the firm's profit function in time period *t* as $\pi_{jt}(\boldsymbol{p}, \boldsymbol{w}, R_{jt})$, where R_{jt} is the firm-specific baseline discharge limit in time period *t*. In this scenario, if the regulator is able to adjust the limit for the firm in each time period, she maximizes social welfare by choosing a series of discharge limits, R_{jt}, for $t = 1, \dots, T$, such that the marginal benefits of greater pollution in any given time period equal the marginal costs of greater environmental damages:

$$\frac{\partial \pi_{jt}(\boldsymbol{p}, \boldsymbol{w}, R_{jt})}{\partial R_{jt}} = \frac{\partial D(E_t)}{\partial E_t} \ \ for\ \ t = 1, \dots, T. \tag{6}$$

The same is trivially true if the regulator must set a time-invariant uniform discharge standard $\bar{R}$ during all time periods, $t = 1, \dots, T$, but can issue an exemption in every period; the regulator sets each exemption to reflect the optimal discharge limit for each time period.

However, institutional constraints may force the regulator to impose $\bar{R}$ with no discretion for exemptions. As before, this standard may be established without regard

[4] In the Clean Water Act context, if a discharger simply needs time to come into compliance, the regulator may grant a compliance schedule. When feasible, a compliance schedule is designed such that the firm's compliance does not generate substantial and widespread socioeconomic impacts on the local community. Moreover, if abatement costs associated with meeting a quality-based discharge limit are expected to generate substantial and widespread socioeconomic impacts in the foreseeable future, the regulator may grant a change of use for the affected water body so that the associated discharge limit is less stringent.

to optimality conditions, as in the Clean Water Act case, or may be chosen as a constrained optimum, as in the zoning case. The latter case is our focus for the rest of this subsection. The constrained welfare-maximizing standard, $\bar{R}^*$, accounts for discounted benefits and costs over the time horizon T, using discount factor β, rather than the benefits and costs in each time period. $\bar{R}^*$ is identified by an expression similar to the static case with multiple firms (see equation (4)) in which, rather than aggregating over multiple firms, the expression aggregates across multiple time periods for the same firm:

$$\sum_{t=1}^{T} \beta^{t-1} \frac{\partial \pi_{jt}(\boldsymbol{p},\boldsymbol{w},\bar{R}^*)}{\partial R_{jt}} = \sum_{t=1}^{T} \beta^{t-1} \frac{\partial D(\bar{R}^*)}{\partial E_t}. \tag{7}$$

Since the damage function does not vary over time, this summation simplifies to the following:

$$\sum_{t=1}^{T} \beta^{t-1} \frac{\partial \pi_{jt}(\boldsymbol{p},\boldsymbol{w},\bar{R}^*)}{\partial R_{jt}} = \left(\frac{1-\beta^T}{1-\beta}\right) \frac{\partial D(\bar{R}^*)}{\partial E_t}. \tag{8}$$

A time-invariant discharge limit for a firm is not optimal in the presence of exogenously changing abatement costs. Compared with the first-best abatement path that equalizes marginal benefits and marginal costs in each period, under a time-invariant limit, the firm overabates in some periods and underabates in others.

The regulator can improve social welfare by granting the firm a temporary exemption in earlier time periods when abatement costs are high. To demonstrate this point, we consider a single time period, $\tau < T$. Holding the firm's discharge limit at the time-invariant standard $\bar{R}$ for all other time periods, a marginal increase in the discharge limit during time period τ to a level $R_{j\tau}$ above $\bar{R}$ improves social welfare if the following holds:

$$\frac{\partial \pi_{j\tau}(\boldsymbol{p},\boldsymbol{w},\bar{R})}{\partial R_{jt}} - \frac{\partial D(\bar{R})}{\partial E_t} > 0. \tag{9}$$

If the time-invariant standard is set at the constrained optimum $\bar{R}^*$, as defined by equation (7), and the marginal benefits of a looser limit, $\frac{\partial \pi_{jt}(\boldsymbol{p},\boldsymbol{w},R_{jt})}{\partial R_{jt}}$, fall over time, then the inequality (9) is satisfied in earlier periods but not in later periods. As a result, the regulator can increase social welfare by granting exemptions for the firm in periods $t = 1, \ldots, \tau^*$, where τ^* is the last period in which inequality (9) is met.

As with the static setting, if exemptions are anticipated, then the optimal time-invariant discharge standard, $\bar{R}^*$, is tighter than the time-invariant standard in a system that does not allow exemptions. In other words, a welfare-maximizing regulator who is able to grant an exemption should optimize over three elements: (1) an exemption horizon, τ^*; (2) an exemption limit, R^1, imposed between periods 1 and τ^*; and (3) a baseline discharge limit, R^0, imposed after the exemption ends (between periods τ^* and T).

In this case, exemptions again offer the opportunity to increase societal net benefits, because the policy context constrains the regulator's efficient deployment of discharge limits. As with the static setting, key caveats must apply: the regulator must aim to maximize social welfare and possess information identical to the information possessed by regulated firms. In this multiperiod setting, another caveat is also key: technological improvement must be exogenous. If improvement is endogenous, the opportunity to secure an exemption influences dynamic incentives. Specifically, relaxing a limit lowers the pace of technological improvement. At best, this disruption detracts from the social gains offered by exemptions. Worse yet, this disruption may overwhelm the social gains, making the use of exemptions socially harmful.

We do not explicitly model endogenously determined technological improvement because a robust literature reveals the complications introduced by this feature. Milliman and Prince (1989) lay the foundation for exploring firm incentives to promote technological change in pollution control efforts in various policy settings. Subsequent studies add to this policy assessment (Biglaiser and Horowitz 1994; Fischer et al. 2003; Parry 1995; Parry et al. 2003). Requate (2005) surveys the dynamic incentives generated by environmental policy instruments.

4.3. Basic Model 2: Exemptions Affect the Labor Market

We next consider the case in which discharge limits affect the labor market on which firms depend. Consideration of input and output prices as endogenous is not standard in the type of welfare analysis conducted here. However, as shown below, in some conditions, this consideration can prove welfare relevant. Moreover, labor market impacts are a central concern for policymakers and are often the basis for resistance to environmental regulations and, consequently, the motivation for exemptions. References to "job-killing regulations" are not limited to political debates; they also carry significant legal relevance, such as when EPA assesses the social and economic impacts of regulations under the Clean Water Act.

Impacts on the labor market can arise even in competitive markets, where firms and consumers are price takers (Berman and Bui 2001; Hafstead and Williams 2018). If many firms are affected by changes to discharge limits in the form of exemptions such that the aggregate effects are considerable, prices adjust. If an exemption changes input or output prices, we must account for the effects of exemptions on both firms' profits and households' indirect utility. In this section, we consider the welfare relevance of such effects. While we focus on the labor market, we could apply the same approach to situations where other input or output markets are affected and reach the same conclusion: if the market does not exhibit preexisting distortions, then net welfare does not change in those markets, though welfare may move from one party to another; however, if a preexisting distortion exists, an exemption can increase overall welfare.

Given this focus, our next model allows a firm to adjust inputs and outputs in response to the exemption so that the price of labor changes (though all other prices stay fixed). This arrangement is plausible if (1) markets are competitive and (2) outputs and inputs other than labor are geographically mobile (i.e., frictions keep only labor from moving freely). In this case, the amount of aggregate production influences the local labor market but not national product markets.

We assume again that the market consists of *J* firms and the regulator is constrained to impose the same limit based on a uniform discharge standard, denoted here as R^0 to allow us to highlight changes in *both* limits and wages, on all firms. The regulator can choose to grant exemptions to some firms, relaxing the limits they face. Let R_j^1 represent the discharge limit faced by the *j*th firm if granted an exemption, where $R_j^1 > R^0$.

If the exemptions are large enough in aggregate that the labor market is affected, the labor demand curve shifts but prices for other inputs and outputs remain unchanged. This shift in labor demand changes the labor wage in the local market, denoted as w_0, from w_0^0 to w_0^1. The net effect of exemptions on the maximized profits of each firm *j* that receives an exemption is

$$\pi_j(\boldsymbol{p}, \boldsymbol{w}^1, R^1) - \pi_j(\boldsymbol{p}, \boldsymbol{w}^0, R^0), \tag{10}$$

where w^0 and w^1 represent the vectors of input prices before and after the change in wage, respectively. We decompose this difference in profit levels as follows:

$$\pi_j(\boldsymbol{p}, \boldsymbol{w}^1, R^1) \underbrace{-\pi_j(\boldsymbol{p}, \boldsymbol{w}^1, R^0) + \pi_j(\boldsymbol{p}, \boldsymbol{w}^1, R^0)}_{=0} - \pi_j(\boldsymbol{p}, \boldsymbol{w}^0, R^0), \tag{11}$$

which we rewrite as a sum of definite integrals:

$$\int_{R^0}^{R^1} \frac{\partial \pi_j(\boldsymbol{p}, \boldsymbol{w}^1, R)}{\partial R} dR + \int_{w_0^0}^{w_0^1} \frac{\partial \pi_j(\boldsymbol{p}, \boldsymbol{w}, R^0)}{\partial \boldsymbol{w}_0} d\boldsymbol{w}_0. \tag{12}$$

The first integral in equation (12) captures the direct effect on maximized profits of the change in abatement costs that results from the increase in discharges from R^0 to R^1, evaluated at $\boldsymbol{w}^1$. We denote this component as ΔC_j, which is positive because it represents the direct effect of the reduced abatement burden. The abatement cost savings that result from the exemptions may stem from changes in processes or inputs, as well as the profit ramifications of increased output. The second term in equation (12) is the effect on the firm due to the change in the wage. The effect of a pollution discharge limit on labor demand can be either positive or negative. The wage moves in the same direction as the change in labor demand.

The effect of an exemption on firms' labor demand is the net effect of the firms' changes in output level and changes in input mix. Typically, environmental regulation increases the marginal cost of production, decreasing the optimal level of output for each firm. Since we assume that firms cannot enter the market, this decrease translates into a reduction in industry output, lower overall demand for labor, and therefore a lower wage. Through this channel, a *relaxation* of the limit from R^0 to R^1 leads to an increase in output and labor demand (if quantity of labor increases with output) and thus the wage. On the other hand, exemptions can also affect labor demand directly, since inputs are required in the abatement process itself. If pollution abatement is labor-intensive, an exemption decreases those labor requirements, counterbalancing the effect of the change in output, and could, in net, decrease labor demand. Intuitively and anecdotally, an exemption is more likely to lead to wage increases than wage decreases.

If the supply curve governing the firm's labor market is elastic, then the change in labor demand affects w_0. Let $h_j^D(\boldsymbol{p}, \boldsymbol{w}, R^0)$ reflect firm *j*'s demand for labor. Since $\frac{\partial \pi_j(\boldsymbol{p}, \boldsymbol{w}, R^0)}{\partial \boldsymbol{w}_0} = h_j^D(\boldsymbol{p}, \boldsymbol{w}, R^0)$, the effect of the wage change on firm profit is captured by the area under the original (no-exemption) labor demand curve between the old and new wage levels.

A wage rate change affects households as well. Labor suppliers benefit if the wage rate rises and suffer if it declines. To calculate the equivalent variation, we specify the household's expenditure function, $e_i(\mathrm{p}, \mathrm{w}, U)$, that is, the exogenous income that allows household *i* to achieve utility U at the given input and output prices. The equivalent variation of the change in the wage rate is as follows:

$$EV = e_i(\boldsymbol{p}, \boldsymbol{w}^0, U^1) - e_i(\boldsymbol{p}, \boldsymbol{w}^0, U^0) = e_i(\boldsymbol{p}, \boldsymbol{w}^0, U^1) - e_i(\boldsymbol{p}, \boldsymbol{w}^1, U^1). \qquad (13)$$

The substitution in the second expression of equation (13) follows from this relationship: $e_i(\boldsymbol{p}, \boldsymbol{w}^0, U^0) = e_i(\boldsymbol{p}, \boldsymbol{w}^1, U^1)$. We can express the right-hand side of equation (13) as the definite integral $-\int_{w_0^0}^{w_0^1} \frac{\partial e_i(\boldsymbol{p}, \boldsymbol{w}, U^1)}{\partial \boldsymbol{w}_0} dw_0$. Let $h_i^S(\boldsymbol{p}, \boldsymbol{w}, U^1)$ reflect the compensated labor supply curve, where $h_i^S(\boldsymbol{p}, \boldsymbol{w}, U^1) = \frac{-\partial e_i(\boldsymbol{p}, \boldsymbol{w}, U^1)}{\partial \boldsymbol{w}_0}$. The impact of the exemptions on the *i*th household is thus the area behind its compensated labor supply curve, $EV = \int_{\boldsymbol{w}_0^0}^{\boldsymbol{w}_0^1} h_i^S(\boldsymbol{p}, \boldsymbol{w}, U^1)\, d\boldsymbol{w}_0$.

Combining the effects on firms and consumers, the net welfare effect of the exemptions, denoted as ΔW, is as follows:

$$\Delta W = \sum_j \left(\Delta C_j - \int_{\boldsymbol{w}_0^0}^{\boldsymbol{w}_0^1} h_j{}^D(\mathbf{p}, \mathbf{w}, R^0)\, d\boldsymbol{w}_0 \right) + \sum_i \left(\int_{\boldsymbol{w}_0^0}^{\boldsymbol{w}_0^1} h_i^S(\mathbf{p}, \mathbf{w}, U^1)\, d\boldsymbol{w}_0 - \Delta D_i \right), \tag{14}$$

where ΔD_i is the change in damages to the *i*th household that results from the change in discharges prompted by the exemptions.

Grouping together the labor supply and demand curves, we obtain the following:

$$\Delta W = \sum_j \Delta C_j + \int_{\boldsymbol{w}_0^0}^{\boldsymbol{w}_0^1} \left[\sum_i h_i^S(\mathbf{p}, \mathbf{w}, U^1) - \sum_j h_j{}^D(\mathbf{p}, \mathbf{w}, R^0) \right] d\boldsymbol{w}_0 - \sum_i \Delta D_i, \tag{15}$$

where the integrand, $\sum_i h_i^S(\boldsymbol{p}, \boldsymbol{w}, U^1) - \sum_j h_j{}^D(\boldsymbol{p}, \boldsymbol{w}, R^0)$, is the equilibrium difference between the quantity supplied and quantity demanded at a given wage level. Following Just et al. (2004) and the proof of Bullock (1993), if the labor market remains in equilibrium, we can evaluate the integral in equation (15) as a line integral along which supply equals demand so that the integrand is equal to zero at all values of w_0. Hence, the welfare effects caused by the wage change exactly cancel each other out. That is, these components represent a transfer of welfare between labor buyers and sellers; in the likely case that exemptions increase the wage, welfare flows from firms to workers. The amount of the transfer can be thought of as the share of the benefits of the exemption that is enjoyed by workers instead of the owner of the firm. The net welfare effect of the exemptions is captured by the two remaining terms:

$$\Delta W = \sum_j \Delta C_j - \sum_i \Delta D_i. \tag{16}$$

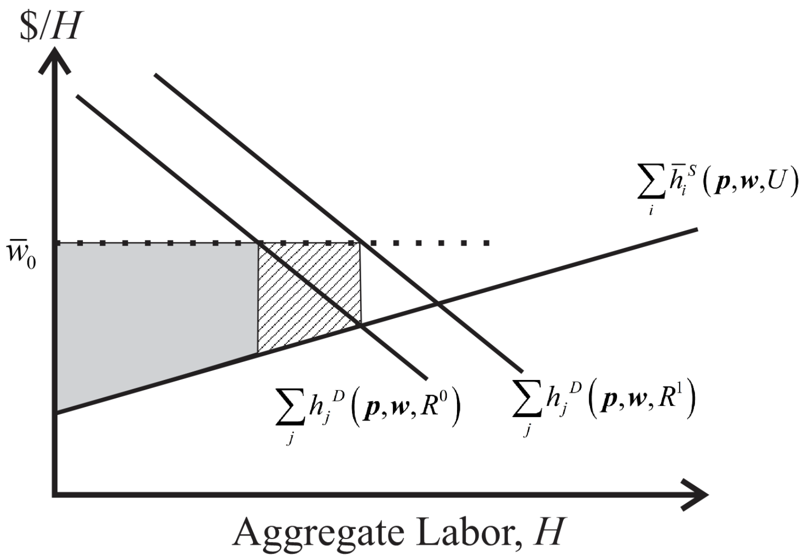
In other words, the net value of the welfare consequences of the exemptions consists of the change in abatement costs themselves and the change in environmental damages. Even if policymakers hope to generate positive labor market effects by granting exemptions, if the labor market is always in equilibrium, the costs to firms exactly offset the gains to workers. In this case, as in Subsection 4.2.2, a social welfare–maximizing regulator grants exemptions to those firms that face the highest abatement costs, ΔC_j, if the abatement costs savings would outweigh the increased pollution damages.

However, policymakers may still choose to consider the welfare impacts in the labor market for several reasons. First, while the net impacts through the labor market are zero, this channel redistributes surplus between workers and employers. If exemptions positively affect workers and negatively affect employers, and the regulator places different weights on these groups, then the labor impacts are no longer perfectly offsetting in the regulator's eyes. Section 5 explores this possibility.

A second reason that policymakers may consider the labor market impacts of exemptions arises when the labor market is not in equilibrium. For example, unemployment impacts are an important factor when EPA considers exemptions to mitigate "substantial and widespread economic and social impacts" of stringent regulation from the Clean Water Act. As we will show, this can be justified from a standard social welfare perspective.

Let us assume that the wage rate is sticky at $\bar{w}_0$, perhaps because of rigidities in the labor market such as a binding minimum wage. In such a situation, a marginal increase in the demand for labor does not affect the wage rate. Hence, firms demanding labor face no impact; that is, $\int_{\bar{\boldsymbol{w}}_0}^{\bar{\boldsymbol{w}}_0} \sum_j {h_j}^D(\boldsymbol{p}, \boldsymbol{w}, R^0)\, d\boldsymbol{w}_0 = 0$. However, the quantity of labor demanded at the prevailing wage may be less than the quantity supplied; that is, involuntary unemployment exists. This also means that rents accrue to the labor force, since the wage rate exceeds the marginal worker's opportunity cost. Assuming optimal sorting in which those with the lowest opportunity costs are employed first, the preexemption surplus to labor is represented by the gray-shaded area in Figure 1. A change in labor demand to $\sum_j {h_j}^D(\boldsymbol{p}, \boldsymbol{w}, R^1)$ as a result of exemptions alters that surplus, with an increase in surplus to labor indicated by the diagonally striped area. This change, which is positive for a labor demand increase and negative for a labor demand decrease, is welfare relevant and should be taken into account when calculating the welfare consequences of exemptions. However, note that only the increment to labor surplus should be included. The entire change in labor income precipitated by exemptions should be considered only in the extreme case when the opportunity cost of unemployed workers is zero. If the regulator inappropriately includes the entire change in labor income in her welfare analysis, too many exemptions would be granted, and they would serve as a policy tool for ill.

Figure 1. Welfare Consequences in the Labor Market in the Presence of Involuntary Unemployment



In this way, any time there is a distortion in this secondary market, the presence of rents prior to the exemption means that the welfare effects to firms and consumers will not perfectly offset each other. For example, if the discrepancy between the marginal benefit of labor and its marginal cost is attributable to market power, then the rents in the market will accrue to any firm that purchases labor, but the graphical analysis will be quite similar to that in Figure 1.

In summary, as with exemption decisions in general, consideration of secondary market impacts can be for either good or ill.

5. Flexible Weights in Regulator's Optimand

In the preceding sections, we assume the regulator makes decisions to maximize a social welfare function composed of equally weighted costs and benefits accruing to firms and households. However, this need not hold. A growing literature questions the typical approach in which the values of all benefits and costs are treated equally (Coate 2001; Fleurbaey and Abi-Rafeh 2016; Hendren 2017) and argues that regulators should weigh values accruing to members of society differently if society is more concerned about the welfare of disadvantaged or vulnerable people. Alternatively, a regulator might weight welfare function components unequally if she is particularly answerable to some subset of society.

We explore these cases by adding weights to the regulator's optimand. Let α, δ, and γ represent the weights placed by the regulator on profits enjoyed by firm owners, indirect utility of households, and environmental damage costs, respectively, and let θ_n represent the weight that the regulator puts on the welfare that accrues to community *n* out of communities 1 to *N*. With these weights, we can rewrite the regulator's optimand, which we still denote as *W* even though it need not represent social welfare:

$$W = \sum_n \theta_n \left[\alpha \sum_{j \in J_n} \pi_j(\boldsymbol{p}, \boldsymbol{w}, R_j) + \delta \sum_{i \in I_n} V_i(\boldsymbol{p}, \boldsymbol{w}, m) - \gamma \sum_{i \in I_n} D_i(E) \right], \quad (17)$$

where J_n and I_n are the sets of firms and households in community *n*.

In general, these weights have two implications for our welfare analysis. First, the weights change the marginal condition that drives the regulator's decision; if the weight on profits exceeds the weight on households' pollution damages, then the likelihood of an exemption is greater than in the case of an equally weighted welfare function, and vice versa. Second, transfers of welfare between labor sellers and labor buyers are no longer welfare-neutral. Recall that when an exemption increases labor demand, it results in transfers from firms to households. Without welfare weights, these effects are offsetting, but if weights place more importance on firms than on households, then the labor market impacts will affect the planner's calculus, reducing the likelihood of an exemption, and vice versa.

Practically speaking, why would unequal weights arise in a regulator's optimand, and what are their implications? First, across communities, society might weight households more heavily than firms (so $\delta > \alpha$) because households might represent more vulnerable populations. In this case, pollution damages are weighted more heavily than firm profits, decreasing the likelihood of an exemption, particularly so if the baseline discharge limit is not reduced for firms that do not receive an exemption. However, if labor market impacts exist and an exemption would increase labor demand, then the likelihood of an exception grows, because the households would benefit from increased wages. In this case, the regulator considers jobs as a net benefit in the weighted social welfare function. If this effect is sufficiently strong, the regulator is more likely to grant an exemption than when applying an equally weighted welfare function. Alternatively, if society weights firms more heavily (so $\alpha > \delta$), then the opposite holds.

In the preceding cases, we described the unequally weighted optimand as the social welfare function, so by definition, if the regulator is optimizing it, her use of exemptions improves welfare. However, the regulator's optimand could be unequally weighted for reasons that make the optimand differ from the social welfare function. In these cases, since exemptions grant the regulator discretion, exemptions will generally be welfare-decreasing.[5]

If the regulator is captured by industry, she weights firm profits more heavily than household outcomes even though society does not; in the extreme, she might place no weight on household outcomes ($\delta = \gamma = 0$). An exemption saves firms abatement costs. However, an exemption may cause the labor demand curve to shift out, which transfers welfare from firms to workers. Since the net effect of reduced abatement costs and increased labor costs is likely negative, implying greater profits, a regulator captured by industry is more likely to issue an exemption.

If the regulator is parochially focused so that she has jurisdiction in only her own community, $n = 1$, then $\theta_1 = 1$ and $\theta_n = 0 \ \forall n \neq 1$. For example, zoning variances are granted by local boards charged with considering only local welfare. Similarly, under the Clean Water Act, EPA's consideration of costs focuses exclusively on locally borne costs (EPA 1995). Moreover, when a state agency prepares an application for a multiple discharger variance from Clean Water Act water quality–based limits, the agency focuses exclusively on costs borne within that state (EPA 2013). A parochially focused regulator issues the same exemptions as a regulator with a broader perspective if regulatory costs and benefits accrue only in community$n = 1$. However, if some costs or benefits of pollution control are exported, the story changes.

[5] We do not consider the case in which the regulator tightens the baseline discharge limit imposed on firms not granted exemptions to account for the existence of exemptions. If the non-social-welfare-maximizing regulator can adjust the baseline discharge limit, she can set a loose limit instead of issuing exemptions to allow more pollution.

Commonly, pollution is exported, as is the case of nonuniformly mixed water pollution carried downstream out of a community, while abatement costs and labor surpluses accrue locally. In this case, the parochially focused regulator issues too many exemptions, resulting in too much pollution.

In addition, a parochially focused regulator likely undermines cost-effectiveness. For uniformly mixed pollutants, discharges should be distributed across firms so that marginal abatement costs are equal across firms. If the regulator in community $n = 1$ grants an exemption from a regulation that continues to hold in the other jurisdictions, then the equimarginal criterion is unlikely met.[6]

Finally, even if a regulator has jurisdiction over multiple communities, she might weight some of them more heavily than others. The set of weights, θ_n, might now reflect communities' capacities to exert political pressure, as in Earnhart (2004a). If greater power rests in communities with firm owners or communities far from pollution damage, the regulator is likely to grant too many exemptions.[7] If greater power rests with elites who do not supply labor but are affected by pollution, the regulator issues too few exemptions.

[6] Other communities may also grant parochially driven exemptions, especially if firms can relocate based on regulatory costs. This "race to the bottom" could result in a cost-effective allocation if regulations are relaxed to the same level; however, in this scenario, the relaxed level likely would generate too much pollution relative to the optimum.
[7] To draw this conclusion, again we assume that the direct abatement cost savings from an exemption dominate any reduction in wage costs because of labor market impacts.

6. Conclusions

Many laws grant government agencies the discretion to grant exemptions—known also as variances, exceptions, and waivers—as a safety valve that can loosen the stringency of protective restrictions. Government agencies commonly use exemptions in the realm of environmental protection (and other settings), but the implications of this tool have been understudied. In this study, we explore the impact of exemptions to demonstrate that the discretion to grant exemptions can improve social welfare by providing flexibility, though it need not. The welfare-improving outcome relies on relatively heroic assumptions, including that the regulator seeks to maximize social welfare, the regulator possesses full information about regulated firms' cost structures, and the time path of technological improvement is exogenously determined. The discretion granted to a regulator may harm social welfare if any of these assumptions are not satisfied or if the regulator fails to properly consider labor market impacts.

We consider a simple static model with a standard social welfare function under two different sets of assumptions: (1) market prices do not change in response to increases in pollution limits, and (2) the labor wage rate changes, but other markets always remain unchanged. In addition, we consider a model in which abatement costs decline over time. In all cases, we show that an exemption can increase social welfare by giving the regulator discretion to relax a limit that is too tight, for either a single firm or multiple firms—discretion begets flexibility, which yields cost-effectiveness. This result is similar to the welfare-improving effects of other forms of policy flexibility, such as emissions charges.

Exemptions, however, contrast strongly with other policies in the way they offer flexibility. Policies like emission charges offer flexibility to polluters regarding their chosen levels of emissions to take advantage of the private information firms have about their own abatement costs. Exemptions, in contrast, offer discretion to regulatory agencies, allowing for flexible adjustments to otherwise uniformly imposed limits. Under an exemption, polluters still lack flexibility over their emissions levels (specifically, polluters may not legally exceed even adjusted limits and gain no legal benefits by overcomplying with limits).

This welfare-improving exemption case assumes a great deal of information on the part of the regulator. To make optimal exemption decisions, the regulator would require perfect knowledge of the production and abatement costs of each polluting firm, the damage costs associated with pollution, and consumer preferences and the labor supply. It is unlikely that she would possess all this information in reality. Indeed, in most cases, it is the firms' role to submit exemption applications seeking to reduce their regulatory burden. If firms can misrepresent their costs to the regulator, then the welfare gains we have identified may not be achieved. Worse yet, a regulator may exploit her discretion by granting an exemption when it is not merited, which reduces welfare either by granting too many exemptions (reducing efficiency) or by granting them to the wrong entities (reducing cost-effectiveness). To capture these failures, we also consider cases in which the elements in the regulator's optimand are not weighted equally, either across components (firm profits, household consumption utility, and environmental damages) or across communities. If the regulator is captured by an industry, concerns herself only with a local jurisdiction, or cares only about the interests of certain communities, her exemption decisions undermine efficiency and perhaps even cost-effectiveness. In these cases, the regulator uses her discretion against society's best interests.

In addition, we show that the regulator can use the discretion to grant exemptions as a means for providing relief to economically distressed households that supply labor; whether this outcome is desirable is a normative decision left to society.

Since exemptions are reasonably common in the environmental policy realm, among other policy areas, more theoretical and empirical work is needed to examine the practice and the impact of granting exemptions. Future research should explore important questions such as the following: Do regulators grant exemptions in ways that maximize social welfare or to benefit one community (or constituency) at the expense of society as a whole? Does the granting of exemptions demonstrate a regulator's information asymmetry with regard to grantees? Do exemptions create progressive or regressive impacts? How is the surplus generated by an exemption shared between producers and consumers? Do regulated firms face exemption application costs, and do regulators bear costs when granting exemptions? If yes to either, how do these costs alter the efficiency, cost-effectiveness, and distributional impact of exemptions?

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