Police-powers, regulatory takings and the efficient compensation of domestic and foreign investors

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May 19, 2007

Abstract

In customary international and public law, “takings” resulting from regulations designed to protect the public good are generally excluded from compensation rules; this exclusion is known as a police powers carve-out (PPCO). Increasingly, this PPCO is being challenged, particularly in international investment law. This paper analyzes the efficient properties of a PPCO in a model with endogenous regulation, investment and entry. We design a one-parameter family of carve-out/compensation schemes that induce efficient regulation and firm level investment even when the regulator suffers fiscal illusion and the social benefit from regulation is private information to the regulator. We show that offering a carve-out reduces the subsidy to risky industry implicit in compensation rules, thus a carve-out can mitigate the entry problem.

Keywords: regulatory takings, carve-out, expropriation, environment, foreign direct investment, NAFTA, National Treatment.

JEL classification numbers  K3, Q58, F21

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1 Introduction

Over the past 15 years a number of attempts have been made to make regulatory takings compensable. Chapter 11 of the North American Free Trade Agreement (NAFTA) requires host governments compensate foreign investors for losses arising from any “measures tantamount to ... expropriation” (NAFTA Article 1110, parag. 1, emphasis added). This has led investors to sue NAFTA host governments for a number of environment related regulations, including backfilling rules designed to protect native sacred sites, a municipality’s refusal to grant operating permits for a hazardous waste facility, a ban on the import of one gasoline additive and the use of another.\(^1\) At the federal level, bills have been introduced into Congress that would render compensable losses in property values arising from the Endangered Species Act (ESA), the Clean Water Act and the Farm Bill.\(^2\) Finally, ballot initiatives have appeared in a number of states mandating compensation for some forms of regulatory takings. For example, in 2004 Oregon voters passed Ballot Measure 37, which entitles a property owner to compensation for any new land use regulation that “has the effect of reducing the fair market value of the property” (Oregon State Law 197.352 n.d., Subsection 1).

Although the Fifth Amendment to the U.S. Constitution states “...nor shall private property be taken for public use, without just compensation”, most courts refrain from classifying regulatory takings as compensable. Instead, courts have historically acknowledged a carve-out, i.e. a standing exclusion, for takings arising from government exercising its police powers, that is, the state’s right to regulate behavior.\(^3\)

The central efficiency argument in favor of making regulatory takings compensable is fiscal illusion.\(^4\) If regulators discount the costs regulations impose on private citizens, they will tend to regulate too often. There are plenty of reasons to expect regulators will place less than full weight on regulatory costs borne by the private sector. State and municipal governments are elected to maximize local welfare, not the joint welfare of citizens and foreign investors; thus regulatory costs borne by subsidiaries of foreign multinationals may be heavily discounted. Alternately, the source of the fiscal illusion may be the regulatory environment itself:

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\(^1\) These cases are, respectively, Glamis Gold Ltd. v. United States of America (see U.S. Department of State (2005a)), Metalclad Corporation v. United Mexican States (see U.S. Department of State (2005b)), Ethyl Corporation v. Canada (see Canada Department of Foreign Affairs (2004), and Methanex Corporation v. United States of America (see UNCITRAL Tribunal Methanex Corp. v. United States of America (2005)).


\(^3\) Notable exceptions in include Pennsylvania Coal Co. v. Mahon 260 U.S. 393, 415 (1922) and Lucas v. South Carolina Coastal Council 112 S. Ct. 2886, 2895 (1992). In the Pennsylvania Coal case, state regulation prohibiting subsurface mining that endangered surface structures was overturned at the federal level; in the Lucas case, the owner of two undeveloped parcels of land (on an otherwise already developed stretch of coast) was compensated for new regulations that prohibited future development. Fischel (1998) provides an excellent survey of these cases.

\(^4\) There are also compelling fairness arguments favoring compensation. See, for example, Michelman (1967), Fischel and Shapiro (1989), and Niemann and Shapiro (2005). This paper, however, examines only efficiency.
the Endangered Species Act (ESA) “requires that species listing decisions not be based on the consideration of . . . costs and benefits” (Innes, Polasky and Tsahirhart 1998, p.47). Making takings compensable is one way of disciplining regulators.

However just like with outright takings, compensation for regulatory takings distorts investment decisions. Blume, Rubinfeld and Shapiro (1984) (hereafter referred to as BRS) argue that compensation effectively insures investors against states of the world in which their land would have higher value in the hands of government; as a result property owners will over-invest if assured of compensation for subsequent takings. BRS show this compensation-as-insurance problem can be remedied by making compensation lump-sum. Nevertheless, compensation transfers rents from society to investors and so acts like an implicit subsidy to at-risk industries. We argue this generates an entry problem, whereby compensation leads to inefficiently inflated industry.

In this paper we propose a mechanism that simultaneously addresses the fiscal illusion and insurance problems yet still grants a carve-out for seemingly bona fide public regulation. Specifically, we examine the efficiency properties of a police powers carve-out (PPCO)—this is a rule under which the regulator is exempt from paying compensation if and only if the court perceives that the social benefits from regulation are sufficiently high; otherwise, takings are compensable. We show that an appropriately designed PPCO induces efficient regulation despite fiscal illusion even when there is asymmetric information between the regulator and the courts. We also show that for any PPCO there exists a linear compensation scheme that induces both efficient regulation and firm level investment if investors are non-strategic.

PPCOs have received scant attention in Takings analyses. The exception is Miceli and Segerson (1994) who propose an Ex Post rule under which a regulator is exempt from paying compensation if and only if the taking is socially efficient. Their analysis is limited to a full information environment in which courts can perfectly observe the social costs and benefits of a takings. In practice, though, courts charged with adjudicating takings cases receive noisy signals of the social benefits from takings. This is particularly true in the case of environmental regulation where the regulating agency may have intangible hands-on knowledge of the damages avoided via regulation. The courts, in contrast, must rely on second hand accounts—expert witnesses and a paper trail of often conflicting scientific reports—to deduce avoided damage.5

Unlike previous research on Takings, we examine how compensation and a carve-out affect entry decisions. As suggested above, we show compensation rules effectively transfer expected rents from society to investors. We argue this will promote entry above what would occur if the fiscal illusion problem could be solved absent compensation. We show that broadening the carve-out tends to reduce the size of the implicit

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5Hermalin (1995) similarly examines compensation schemes when information is asymmetric and the regulator suffers fiscal illusion. Hermalin’s analysis allows for strategic investors—our baseline model does not—but excludes the possibility of a PPCO. Hermalin argues efficient investment and regulation are possible if the state can “demand payments from its citizens in exchange for not taking their property.” (p.75) Nosal (2001) similarly proposes a scheme involving a transfer from individuals to the state. In our model we do not grant the regulator the power to extort payments from landowners, as this would generate its own moral hazard problem.
transfer to investors, and so granting a PPCO can help mitigate the entry problem. However we also find that broadening the carve-out does not eliminate this transfer, and so our proposed scheme does not induce efficiency on all levels.

Although this paper applies to the problem of carve-outs and regulatory takings in general, we pay special attention to the case where investors are foreign nationals. There are more than 2,500 international investment agreements, including bilateral investment treaties, and regional agreements such as Chapter 11 of the North American Free Trade Agreement (NAFTA). The vast majority of these agreements give foreign investors the right to file a compensation claim against a host government using an international tribunal. In contrast to domestic law in the participating countries (on which domestic investors must rely) international investment treaties generally contain strict definitions of expropriation. According to the letter of many IIAs there is no PPCO for regulations to protect health, safety, or the environment, and thus any new regulations for these purposes may be construed as regulatory takings worthy of compensation. Despite the clear letter of the law, many tribunals have granted PPCOs in their compensation rulings, precipitating a lively debate among legal scholars and practitioners.\(^6\)

The reluctance of tribunals to apply the strict definitions included in most investment agreements is probably driven by political rather than economic considerations. A PPCO has particular political appeal when the defending host is a developing country government who is trying to introduce tougher environmental standards, and the investor a large multinational from a wealthy country. Empirical evidence suggests that this scenario is more than merely an emotive theoretical possibility. Developing countries are the defendants in the vast majority of cases, and host governments claimed protection of the public good as the primary motive for their allegedly expropriatory actions in nearly a quarter of the international investment agreement cases for which we were able to find information.\(^7\) As noted, the expropriation clauses found in IIAs only apply to foreign investors. When viewed in light of the entry problem, this creates an obvious level playing field problem. Moreover, National Treatment rules (which require host governments treat foreigners no less favorably than domestic investors) prevent host governments from charging foreigners up front taxes so as to offset this implicit subsidy.

Another point at which we depart from the Takings literature is our focus on production externalities. Most analytic models presume the social benefit from a taking arises via the transfer of private property into public hands. In short, takings provide new public goods at the expense of investors or property owners. However the investor-to-state lawsuits prompted by NAFTA’s Chapter 11 that have drawn the most criticism have concerned environmental regulation. Accordingly, in our model the benefit of a taking is measured in terms of damage avoided. As such regulations protect the public good, they fall under the usual definition of a state’s police powers. Much of our analysis is equally valid under either interpretation, and many of

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\(^6\)See for example Been and Beauvais (2003), Tschen (1999), and Turk (2005).

\(^7\)Seven cases out of twenty nine. Source: the website of the International Centre for the Settlement of Investment Disputes.
the arguments we offer in defense of a carve-out for health, safety and environmental regulations extend to carve-outs for pro-active regulation as well.

2 Model

2.1 Actors

There are three actors in our model, a representative investor, a regulator, and an arbitrator. All actors are risk neutral.

We assume the investor is perfectly competitive, chooses investment level $k$ taking the rental price for capital, $r$, as given, and has already entered the industry in question; we analyze the entry decision in Section 5.2. If the investor’s project goes unregulated, she earns variable profits $\pi(k)$ where

$$\pi(k) = pq - c(k, q)$$

in which $q$ is output and $c$ is a cost function that is increasing in $q$ and decreasing in $k$. $p(k)$ and $q(p)$ denote the equilibrium price and demand; $p(k)$ satisfies $p(k) = c_q(q, k)$. Because firms are price takers, $S'(k) = -c_k(q, k)$ evaluated at $q = q(p(k))$. Let $U(p(k))$ denote consumer surplus while pecuniary social surplus from the project is $S(k) = U + \pi$.

The regulator has the authority to unilaterally decide whether to shut the project down. If the project goes unregulated the region in which the investment is installed suffers harm $H$; we will regularly refer to this harm as environmental damage however other interpretations are equally valid. When the investor is choosing $k$, $H$ is a non-negative random variable with PDF, CDF $f(H)$ and $F(H)$ respectively. When the regulator is deciding whether to shut down the project, she knows the realized value of $H$. Regulation causes a loss of surplus $S(k)$ and avoids the environmental cost $H$.

Regulation automatically prompts an investor claim for compensation. The arbitrator determines whether the regulator must compensate the investor as well as the size of the compensation payment. When deciding whether compensation is due, the arbitrator compares observed harm from the project to some benchmark. The level of harm observed by the arbitrator is $\eta H$. When the regulator decides whether to shut down the project, $\eta$ is a random variable with PDF, CDF $g(\eta)$, $G(\eta)$; when adjudicating the investor’s compensation claim, the arbitrator observes $H\eta$, the product of the realized values of $H$ and $\eta$.

The following timeline lays out the three stages of the model.

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8In practice, the harm arising when the project is unregulated may be a function of $k$. In footnote 18 we show that in such cases an additional policy tool—a capital tax—is appropriate.

9Our model does not allow for asymmetric information regarding investor profits. This is reasonable when the entity impacted by regulation is a firm: the value of the “taken” enterprise will be reflected in the market price or share value. When the subject is a household facing new restrictions on the use of private property this assumption is less defensible.
First Stage [Investment]: investor chooses investment level

<Nature reveals H to host>

Second Stage [Regulation]: host decides whether to regulate

<Nature reveals H_\eta to tribunal and public>

Third Stage [Litigation]: Tribunal rules whether Host must pay compensation.

In the analysis to follow, we employ the following terminology:

**Ex ante expectation**: expectation before any uncertainty is resolved

**Second stage expectation**: expectation after level of harm is realized but before noise in tribunal’s signal is realized

**Ex post efficiency**: efficient given investment level k by investor and realized harm H

### 2.2 Benchmark—Socially efficient regulation and investment

Regulation is ex post efficient if and only if $H > S(k)$; the probability of (efficient) regulation is therefore $1 - F(S(k))$. Under efficient regulation, the expected social welfare for given $k$ is

$$V(k) \equiv E_H \max \{0, S(k) - H\} = \int_0^{S(k)} (S(k) - H) f(H) \, dH.$$  

The socially optimal level of $k$ maximizes $V(k) - rk$ giving the first order condition

$$S'(k)F(S(k)) = r,$$

which simplifies to

$$-c_k (q(p(k)), k) F(S(k)) = r. \quad (1)$$

We use $^*$ to denote the optimal level of a variable or function, so $k^*$ is the socially optimal level of investment and $F^* = F(S(k^*))$. For convenience we assume $F^* \pi^* - rk^* > 0$: the firm’s profits are positive under socially efficient investment and regulation.

The following sections analyze regulation and investment in the decentralized setting. As usual we begin our analysis with the final stage of the game.
3 Arbitration

The arbitrator observes a noisy signal, $H\eta$, of damages where $\eta$ is a random variable with density and CDF $g, G$. For simplicity of exposition we assume that the support of $\eta$ is the positive half-line, except where we explicitly state otherwise. We also assume the distribution of $\eta$ has no mass points. If the signal is unbiased, then $E\eta = 1$. If the court is equally likely to overstate as to understate true damages, then $G(1) = 0.5$.

The arbitrator applies the following rule: if $\eta H > \chi(k)$ then the regulator need not compensate the investor. If instead $\eta H \leq \chi(k)$ then the regulator must pay the investor compensation $\theta(k)$.

$\chi(k)$ is the minimum level of environmental damage necessary for the arbitrator to accept a police powers defense from the regulator; when the arbitrator observes damage $\eta H < \chi(k)$ the police powers defense is rejected and regulation is deemed a compensable taking. Thus the function $\chi(k)$ is an inverse measure of the police powers carve-out. Hereafter we refer to $\chi(k)$ as simply the carve-out. Given two carve-outs, $\chi(k)$ and $\tilde{\chi}(k)$, we say that $\chi(k)$ is a broader carve-out if $\chi(k) \leq \tilde{\chi}(k)$ and the inequality is strict for a set of positive measure. Denote the carve-out/compensation scheme applied by the arbitrator as $M(k, H\eta)$:

$$M(k, H\eta) = \begin{cases} 0 & \text{if } H\eta > \chi(k) \\ \theta(k) & \text{if } H\eta \leq \chi(k) \end{cases}.$$  (2)

We assume $M$ is predetermined by either the law of the land or an international investment agreement (IIA); the arbitrator has no discretionary power when adjudicating cases. In subsequent sections we focus on designing $M$ so as to induce efficient regulation and firm level investment.

4 Regulatory Stage

The regulator does not give full weight to the payoffs of the investor. We model this cost-internalization failure with the parameter $\beta \in [0, 1]$. $\beta$ is the weight given to investor payoffs in the regulator’s welfare function; viewed alternately, $1 - \beta$ reflects the degree of “fiscal illusion” suffered by the regulator.

When deciding whether to shut down the project, the regulator knows $H$ but not $\eta$. In the absence of regulation, the host’s payoff is

$$V^N(k, H) = U(k) + \beta \pi(k) - H$$

and with regulation the expected payoff is

$$V^R(k, H) = -[1 - \beta] E_\eta (M(k, H\eta)) = -[1 - \beta] \theta(k) \frac{\chi(k)}{H}.$$
The host regulates if and only if
\[ V^N = U(k) + \beta \pi(k) - H < -[1 - \beta] \theta(k) G \left( \frac{\chi(k)}{H} \right) = V^R. \] (3)
or, alternately,
\[ V^N = S(k) - [1 - \beta] \pi(k) - H < -[1 - \beta] \theta(k) G \left( \frac{\chi(k)}{H} \right) = V^R. \] (4)

**Proposition 1** When
\[ \theta(k) = \frac{\pi(k)}{G \left( \frac{\chi(k)}{S(k)} \right)} \] (5)

the regulator shuts down the project if and only if it is ex post efficient to do so.

**Proof.** Regulation is ex post efficient if and only if \( S(k) - H < 0 \). The regulator will shut down the project if and only if \( V^N < V^R \). Subtracting \( V^R \) from both sides and substituting \( \pi(k)/G \left( \frac{\chi(k)}{S(k)} \right) \) for \( \theta(k) \) implies regulation occurs if and only if \( S(k) - H - [1 - \beta] \pi(k) \left[ 1 - \frac{G \left( \frac{\chi(k)}{S(k)} \right)}{G \left( \frac{\chi(k)}{H} \right)} \right] < 0 \). As \( G \) is non-decreasing in its argument, \( 1 - \frac{G \left( \frac{\chi(k)}{S(k)} \right)}{G \left( \frac{\chi(k)}{H} \right)} \) \( \leq 0 \) for \( H \geq S(k) \). Hence the regulator will shut down the project if and only if \( H > S(k) \). \( \blacksquare \)

The following remarks follow from Equation (5).

**Remark 1** When \( \beta < 1 \), all carve-out schemes that induce efficient regulation require that the host’s expected compensation equal the firm’s lost profits \( \pi(k) \) when realized harm \( H \) equals \( S(k) \).

This result mirrors a general principle in enforcement economics: “[t]he optimal fine equals the harm, properly inflated for the chance of not being detected...” (Polinsky and Shavell 1992, p.133). However in our case the compensation rule (5) does not lead to full cost-internalization for all realized \( H \). When \( H > S(k) \), for example, the regulator’s expected compensation payout is less than \( \pi(k) \). This makes shutting down the project more attractive to the regulator than it would to, say, a social planner. However because this under-internalization only occurs when \( H > S(k) \)—i.e. when the project should be shut down anyway—the regulator’s actions are ex post efficient nevertheless.\(^{10}\)

\(^{10}\)Similarly, when \( H < S(k) \) the regulator’s (second stage) expected payout is greater than \( \pi(k) \), making regulation less attractive to the regulator than it would be to a social planner.
Remark 2 Define strict compensation as \( M(k, H\eta) = \pi(k)\forall \eta \) (i.e. \( \chi(k) = \infty \)); strict compensation induces efficient regulation.

The language of NAFTA’s Chapter 11 suggests there should be no carve-out for bona fide environmental regulation and investors are entitled to compensation equal to the market value of the “taken” firm or property. This matches our definition of strict compensation. Our analysis suggests strict compensation rules will indeed induce efficient regulation. As we verify in the next section, however, it will also induce over-investment.

Remark 3 The compensation scheme that induces ex post efficient regulation given carve-out \( \chi(k) \) is independent of \( \beta \) provided \( \beta < 1 \).

Remark 3 says that the appropriate penalty for correcting the regulator’s fiscal illusion is independent of the degree of fiscal illusion so long as there is any at all. Mathematically this is obvious from equation (4): only when the expected penalty is equal to \( \pi(k) \) will the regulator’s decision rule be identical to the social planner’s at the pivotal damage level \( H = S(k) \). And since the probability the police powers defense will be rejected is independent of \( \beta \) then so is the compensation rule necessary for ex post efficiency.\(^{11}\)

In the discussion above we have focused on cases where \( \beta < 1 \). We note that the compensation rule outlined in equation (5) also induces efficient regulation if \( \beta = 1 \). In this case, though, there are an infinite number of compensation schemes that will similarly induce efficient regulation because the host views any outlays as mere transfers. With this in mind, from here forward we restrict our attention to cases with \( \beta < 1 \).

Remark 4 When there is noise in the court’s signal of damage (i.e. the support of \( \eta \) is not a single point), any compensation scheme that involves a carve-out \( \chi(k) < \infty \) requires \( \theta(k) > \pi(k) \).\(^{12}\)

\(^{11}\)Remark 3 begs an interesting question. If the problem is that the regulator fails to internalize fraction \([1 - \beta]\) of the investor’s costs, why isn’t the appropriate solution a penalty with expected value \([1 - \beta]\pi(k)\), i.e. a penalty equal to the uninternalized externality from regulation? The answer lies with revenue recycling. The entire penalty is recycled back to the investor, whose welfare receives weight \( \beta \) in the regulator’s objective function. Thus fraction \( \beta \) of any penalty \( Y \) is viewed as a benefit from regulation and so will want to shut down the project too often (i.e. at some \( H \) less than \( S(k) \)). Of course the mechanism designer could attempt to correct for this recycling effect by topping up the penalty, setting the penalty equal to \( Y_1 = [1 - \beta]Y + \beta[1 - \beta]Y \), but so long as the full value of the penalty goes to the investor there will be the same feedback effect. Continuing ad infinitum suggests the appropriate penalty would equal \( Y_\infty = [1 - \beta]Y + \beta[1 - \beta]Y + \beta^2[1 - \beta]Y + \ldots \). Using the property \( 1 + \beta + \beta^2 + \ldots = \frac{1}{1 - \beta} \) we see that the only penalty inducing full cost internalization at \( H = S(k) \) in the presence of revenue recycling and fiscal illusion is a penalty with expected value of \( \pi \).

\(^{12}\)This statement relies on the assumption that the support of \( \eta \) is unbounded above. Suppose instead that the least upper bound of the support of \( \eta \) is \( \bar{\eta} < \infty \). In this case, strict compensation transfers expected rents to the investor without promoting efficiency, because there are circumstances where the court awards compensation even though it knows that regulation is justified. For any signal greater than \( S(k)\bar{\eta} \) the court knows that regulation is justified. The compensation scheme can set \( \theta = \pi \) (its lower bound) and use the carve-out \( \chi(k) = S(k)\bar{\eta} \). The host’s ex ante expected savings relative to the strict carve-out is

\[
\pi \int_{S(k)}^{\infty} \left( 1 - G \left( \frac{S(k)\bar{\eta}}{H} \right) \right) f(H) dH.
\]
This remark brings home a simple point: if there are to be times when regulatory takings are non-compensable, ensuring the regulator internalizes expected costs entails that the regulator over-compensates the investor when the courts actually reject the police powers defense. In short, if the regulator wants to be occasionally exempt from paying compensation, when she does have to pay she’ll be paying extra.

**Remark 5** There will be states of the world in which the court commits a type II error, i.e. the courts will reject the police powers defense even though it is valid.

If we restrict out attention to $H > S(k)$ then $G\left(\frac{\chi(k)}{H}\right)$ measures the probability, conditional on $H$, that the court commits a type II error. Provided $\chi(k)/H$ is greater than the lower bound of the support of $\eta$, the probability of a type II error is positive. Thus there are states of the world in which the regulator must compensate the investor even though the courts know that regulation is always socially efficient in equilibrium.

**Remark 6** If the court observes $H$ without noise, any carve-out that satisfies $\chi(k) \geq S(k)$, together with the compensation rule $\theta = \pi$ induces efficient regulation.

In the case where $\chi(k) > S(k)$ the regulator has pay compensation for $H \in (\chi(k), S(k)]$ even though the tribunal knows that regulation is socially optimal. This is akin to Miceli and Segerson’s Ex Post rule, which stipulates that the regulator pays strict compensation if and only if the taking is socially inefficient given (realized) benefits. Miceli and Segerson (1994) consider only the case in which the court perfectly observes the benefits (equivalent to foregone damages in our model) from a taking; our variant on this rule stipulates that, when the court observes $H$ perfectly, any rule that renders the host liable for compensation whenever realized $H$ is less than $S(k)$ induces efficient regulation.

**Remark 7** If the firm generates no externalities but there are non-pecuniary benefits $B$ from shutting down the project, where $B$ is a random variable with pdf, CDF $f, F$, then regulation is ex post efficient whenever the carve-out/compensation scheme satisfies (5).

In much of the Takings literature, letting the investor keep her property causes no externality; it merely precludes benefits $B$ that would arise if the property were in public hands. At least with regards to expectations formed after the realization of $H$ (or $B$), this approach is mathematically equivalent to ours; eliminating the $H$ term from $V^N$ and adding a $B$ term to $V^R$ confirms this. Provided the compensation scheme satisfies (5), this means the ex post efficiency of carve-out is unaffected by whether regulation is defensive—as with environmental and other regulations designed to limit externalities—or proactive as with conventional takings and seizures.
4.1 Compensation as a transfer to industry

Remarks 4 and 5 relate to the regulator’s burden under a carve-out/compensation scheme given a realized harm level $H$. In this subsection we examine the relationship between carve-out breadth and the regulator’s burden before the level of harm has been realized (but after $k$ has been chosen by the firm).

Begin by defining

$$R(k, \chi(k)) = \int_{S(k)}^{\infty} G \left( \frac{\chi(k)}{H} \right) f(H) dH$$

and

$$T(k, \chi(k)) = \theta(k) R(k, \chi(k))$$

respectively as the ex ante probability the regulator will have to pay compensation and the regulator’s ex ante expected compensation outlay.

**Proposition 2** Define $T_s(k) = \left[ 1 - F(S(k)) \right] \pi(k)$ as the transfer implicit in a strict compensation rule and $T(k, \chi(k))$ as the transfer implicit in any ex post efficient compensation scheme with a carve-out $\chi(k)$. If there exists $H_o$ such that

$$G \left( \frac{\chi(k)}{S(k)} \right) > G \left( \frac{\chi(k)}{H_o} \right)$$

and

$$f(H_o) > 0$$

then $T(k, \chi(k)) < T_s(k)$.

**Proof.** By (5) $T(k, \chi(k)) = \pi(k) \cdot G \left( \frac{\chi(k)}{H_o} \right) f(H_o)$. Bringing the $\frac{1}{G(\frac{\chi(k)}{S(k)})}$ term inside the integral gives $T(k, \chi(k)) = \pi(k) \int_{S(k)}^{\infty} G \left( \frac{\chi(k)}{H} \right) f(H) dH$. Because $\frac{G(\frac{\chi(k)}{H})}{G(\frac{\chi(k)}{S(k)})} \leq 1$ for all $H \geq S(k)$ and,

$$\Psi = \int_{S(k)}^{\infty} G \left( \frac{\chi(k)}{S(k)} \right) f(H) dH$$

by (7), there exists some $H_o$ for which $G \left( \frac{\chi(k)}{S(k)} \right) f(H_o) < f(H_o)$, then $\Psi < 1 - F(S(k))$. $\blacksquare$

Proposition 2 confirms that some carve-out is cheaper for the regulator than no carve-out at all. Given that a carve-out essentially promises the regulator some chance that takings won’t be compensable, this isn’t surprising. However it also isn’t a given, since the regulator pays more than costs whenever the police powers defense is rejected. The key lies in the design of $\theta(k)$; as noted earlier $\theta(k)$ is designed so expected payout $\theta(k)G \left( \frac{\chi(k)}{H} \right)$ exactly equals $\pi(k)$ when realized $H$ equals $S(k)$; thus when realized $H$ is greater than $S(k)$—i.e. in all cases in which regulation actually occurs—the expected payout is less than $\pi$. Integrating over $H > S(k)$ yields $T(k, \chi(k)) < \left[ 1 - F(S(k)) \right] \pi(k)$.

Distinguishing between some carve-out and none is not hair splitting. The NAFTA text explicitly states that takings resulting from regulation “for a public purpose”(North American Free Trade Agreement n.d.,
Article 1110, para. 1) are nevertheless compensable.\textsuperscript{13, 14}

Next, we ask how broadening an already existing carve-out affects the regulator’s expected payout. We answer this question in three steps. We begin by showing that broadening the carve-out necessarily raises the compensation level $\theta(k)$ necessary for ex post efficient regulation. We then show that this positive relationship between the breadth of the carve-out and $\theta$ does not imply that the regulator’s second stage expected payout is decreasing in carve-out breadth; it will depend on the curvature of the noise CDF. In our third step we show that this ambiguity extends to the relationship between carve-out breadth and the implicit transfer to industry. Specifically, we provide necessary and sufficient conditions under which broadening the carve-out lowers $T$, and provide examples where these conditions are and are not satisfied.

\textbf{Step 1: the relationship between $\theta(k)$ and $\chi(k)$}

Broadening the carve-out lowers the conditional probability the PPCO defense will be rejected. Ceteris paribus, this would lower the host’s expected costs from regulation and the host would regulate more often. Thus, in order to maintain regulatory efficiency, $\theta$ must be raised when the carve-out is broadened. In particular, $\theta$ must be raised so as to maintain equation (5). Define

$$
\mu(\eta) \equiv g(\eta)\eta/G(\eta)
$$

as the elasticity of the noise CDF. We also introduce a parameter $\rho$ in order to discuss a change that broadens the carve-out. Let $\chi(k)$ be an arbitrary carve-out and let $\epsilon(k) \geq 0$ be an arbitrary function, where the inequality is strict for an interval that includes the current value of $k$. Define $\chi(k; \rho) = \chi(k) - \rho \epsilon(k)$, with $\rho \geq 0$, so $\chi(\rho) \leq 0$; the inequality is strict for an interval that includes the current value of $k$. Thus, a larger value of $\rho$ corresponds to a broader carve-out. Log differentiating (5) gives

$$
\frac{\dot{\theta}}{\rho} = -\mu \left( \frac{\chi(k; \rho)}{S(k)} \right) \frac{\chi(k; \rho) \rho}{\chi(k; \rho)} > 0
$$

\textsuperscript{13}Some courts have taken this new language to heart while others have not. When adjudicating a lawsuit between Mexico and Metalclad, a US waste disposal company, a tribunal ruled that expropriation includes “...incidental interference...even if not necessarily to the obvious benefit of the host State.” (International Centre for Settlement of Investment Disputes 2000, para. 103). Subsequently, when adjudicating the claim by Methanex, a Canadian producer of methanol, against the United States for California’s impending ban on the use of MTBE (in which methanol is an input), a different tribunal concluded “...as a matter of general international law, a non-discriminatory regulation for a public purpose, which is enacted in accordance with due process and, which affects, inter alia, a foreign investor or investment is not deemed expropriatory and compensable....” (UNCITRAL Tribunal Methanex Corp. v. United States of America 2005, p. 278) Because precedence does not have the same standing in international law as in some domestic courts the Methanex ruling does not reinstate the PPCO for future NAFTA lawsuits.

\textsuperscript{14}Other bills have acknowledged a PPCO for only a subset of regulations. O.S.L. 197.352 explicitly acknowledges a PPCO for land use regulation “for the protection of public health and safety” (Subsection 3) but not for other regulations, for example those designed to provide new public goods at the expense of landowners.
where \(^{\dagger}\) indicates percentage change, e.g. \(\dot{\rho} = d\rho/\rho\). Equation (8) confirms that broadening the carve-out translates to higher compensation when paid.

**Step 2: Second stage expected compensation payment**

The relationship between \(\theta\) and carve-out breadth is determined by the curvature of \(G(\cdot)\)—the CDF of the noise in the arbitrator’s signal—at \(\frac{\chi(k; \rho)}{S(k)}\). However whether broadening the carve-out raises or lowers the regulator’s second-stage expected compensation payment \(\theta(k)G\left(\frac{\chi(k; \rho)}{H}\right)\) also depends on the shape of \(G(\cdot)\), this time at a different error value: \(\eta = \chi(k)/H\). Thus whether broadening the carve-out raises or lowers the host’s expected payout conditional on \(H\) depends on how the elasticity of \(G\) varies along \(G\)’s support.

The following lemma and proposition use distributions with unbounded support, but it is straightforward to confirm that the results are unchanged when \(\eta\) or \(H\) have finite supports.

**Lemma 1** For \(H > S(k)\), broadening the PPCO lowers the host’s (second stage) expected payout \(\theta(k)G(\chi(k)/H)\) if and only if \(\mu(\chi(k; \rho)/H) > \mu(\chi(k; \rho)/S(k))\).

**Proof.**

\[
\frac{d}{d\rho} \theta(k)G\left(\frac{\chi(k; \rho)}{H}\right) = \frac{\theta(k)G\left(\frac{\chi(k; \rho)}{H}\right)}{\rho} \left[ \mu\left(\frac{\chi(k; \rho)}{H}\right) \frac{\chi(k; \rho)\rho}{\chi(k; \rho)} + \frac{\dot{\theta}}{\dot{\rho}} \right]
\]

\[
= \frac{\theta(k)G\left(\frac{\chi(k; \rho)}{H}\right)}{\rho} \chi(\chi(k; \rho)\rho) \left[ \mu\left(\frac{\chi(k; \rho)}{H}\right) - \mu\left(\frac{\chi(k; \rho)}{S(k)}\right) \right]
\]

**Step 3: The relationship between \(T\) and \(\chi(k)\)**

We are now in a position to address how broadening the carve-out affects the ex ante expected payout

\[
T(\chi(k; \rho)) \equiv \int_{S(k)}^{\infty} \theta(k)G\left(\frac{\chi(k; \rho)}{H}\right) f(H) dH
\]

from the host to the investor. As mentioned above, broadening the carve-out makes compensation less likely but larger when it is paid. Which dominates in terms of \(T\) depends both on how the elasticity of \(G\) varies along its support and the distribution of \(H\), as laid out by the following proposition:

**Proposition 3** (a) Within the class of compensation schemes that induce efficient regulation, a necessary
and sufficient condition for a broader carve-out to reduce the host’s expected payment $T(\chi(k; \rho))$ is

$$\int_{\chi(k; \rho)/S(k)}^{\infty} \left[ \mu \left( \frac{\chi(k; \rho)}{H} \right) - \mu \left( \frac{\chi(k; \rho)}{S(k)} \right) \right] G \left( \frac{\chi(k; \rho)}{H} \right) f(H) dH > 0 \quad (9)$$

(b) A sufficient condition for a broader carve-out to reduce the host’s expected payout is that $\mu(\eta)$ is a decreasing function for all $\eta \geq \frac{\chi(k; \rho)}{S(k)}$.

Proof. (a) Differentiating $T$ with respect to $\rho$, factoring out the $\frac{\theta \chi}{\chi}$ terms (which are independent of $H$), and converting to elasticities gives

$$\frac{dT(\chi(k; \rho))}{d\rho} = \theta(k) \chi \rho \int_{\chi(k; \rho)/S(k)}^{\infty} \left[ \mu \left( \frac{\chi(k; \rho)}{H} \right) - \mu \left( \frac{\chi(k; \rho)}{S(k)} \right) \right] G \left( \frac{\chi(k; \rho)}{H} \right) f(H) dH.$$

Because $\theta \frac{\chi}{\chi}$ is negative then (9) is a necessary and sufficient condition for $dT/d\rho < 0$.

(b) If $\mu$ is a decreasing function of $\eta$ then $\mu \left( \frac{\chi}{H} \right) > \mu \left( \frac{\chi}{S(k)} \right)$ for all $H > S(k)$. ■

Not surprisingly, $\mu$ decreasing in $\eta$ is a sufficient condition for $T$ to be decreasing in the breadth of the carve-out: when $\mu'(\eta) < 0$ then second-stage expected payouts are decreasing in the breadth of the carve-out for all $H$ and so the ex ante expected transfer must be too. However, as part (a) points out, even if $\mu$ is not monotone decreasing in $\eta$ it is still possible for $dT/d\rho$ to be negative so long as any harm levels at which $\mu(\chi/H) < \mu(\chi/S)$ are sufficiently unlikely.

For some distributions, the host’s expected payment under an efficient regulation is non-monotonic in the breadth of the carve-out. We know from Proposition 2 that a carve-out (i.e. one under which the police powers defense is sometimes accepted) leads to lower expected costs for the host, compared to no carve-out. Therefore, it is not possible – for any distribution of $\eta$ – that broadening the carve-out always increases the host’s expected costs. In order to show that the expected payoff can be non-monotonic in the breadth of the carve-out, it is sufficient to show that in some cases inequality (9) is violated. We demonstrate this possibility using the following:

Example 1 Suppose that $\eta \sim N(1, \sigma^2)$ (so that the signal is unbiased) and let $H \sim U[0, b]$ with $b > 1$; let $S = 1$, so $\bar{z} = \chi$. Making a change of variables, we can write the integral in inequality (9) as

$$\frac{\chi}{b} \Theta \text{ with } \Theta \equiv \int_{\chi}^{\infty} \left( g(z) \bar{z} - \frac{G(z)}{G(\bar{z})} g(\bar{z}) \bar{z} \right) \frac{d\bar{z}}{\bar{z}^2}.$$

We assume that $\chi > 0$, so a broader carve-out increases the host’s expected costs if and only if $\Theta < 0$. Define $p$ as the probability that the court rejects the police powers defense when $H = S$. Suppose that $b = 2 = \sigma$. Figure 1 shows the graph of $p$ as a function of the carve-out $\chi$ (the solid curve) and the graph of $10\Theta$. For this example, $\Theta < 0$ iff $\chi < 2.45$, at which value $p \approx 0.77$. Thus, the host benefits from a
broader carve-out iff under the status quo carve-out the probability that the court rejects the police powers defense (when \( H = S \)) is greater than 0.77.

Figure 1: Solid curve: graph of probability that court rejects police powers defense when \( H = S \). Dashed curve: 10\( \Theta \)

The sufficient condition for the host to prefer a broader carve-out (unlike the necessary and sufficient condition) is independent of the distribution of harm. For a number of well-known distributions, it is easy to confirm that \( \mu (\eta) \) is either (a) decreasing for all \( \eta \) or (b) decreasing for \( \eta \) sufficiently large. For narrow carve-outs, where \( \chi (k) \) is large, the sufficient condition that \( \mu (\eta) \) is decreasing for \( \eta \geq \frac{\chi (k; \rho)}{\chi (k)} \) is easier to satisfy. This observation is consistent with Proposition 2, which states that some carve-out is always better for the host than no carve-out.

The following Remark gives examples of distributions and ranges for which \( \mu (\eta) \) is decreasing. In all cases, the proofs rely on direct calculation; these are available on request.

**Remark 8**

\( a \) For the exponential and the Weibull distributions, \( \mu (\eta) \) is strictly decreasing. When \( \eta \sim U [a, b] \), \( \mu (\eta) \) is strictly decreasing for \( a > 0 \).

\( b \) For the Gamma and the Chi-squared distributions, a sufficient condition for \( \mu (\eta) \) to be decreasing is \( \eta \geq E \eta \). For the Beta distribution, a sufficient condition
for \( \mu (\eta) \) to be decreasing is that \( \eta \) is greater than or equal to a constant that depends on the parameters of the distribution.\(^{15}\) For the Normal distribution (with mean \( \bar{\eta} \) and variance \( \sigma^2 \), a necessary and sufficient condition for \( \mu (\eta) \) to be decreasing is that \( \eta \geq 1.16\sigma + \bar{\eta} \). (The probability that this inequality is satisfied is approximately 0.12.)

For example if \( \eta \) is Normal, Proposition 3 and Remark 8 imply that a broader carve-out (a smaller \( \chi(k) \)) always benefits the host if \( \chi(k) \geq S(k)(1.16\sigma + \bar{\eta}) \). Using the parameters from Example 1 (\( \bar{\eta} = 1 = S \), and \( \sigma = 2 \)) this inequality requires \( \chi \geq 3.32 \). However, Example 1 shows that (when the harm is uniformly distributed), the host prefers a broader carve-out whenever \( \chi \geq 2.45 \). The difference in bounds shows that the sufficient condition does not provide a tight bound. For the Gamma and Chi-squared distributions, a broader carve-out benefits the host if \( \chi(k) \geq S(k)E(\eta) \); for the exponential, Weibull and (positive) Uniform distributions, a broader carve-out *always* benefits the host.

We summarize the results of this section as follows. It is possible to induce efficient regulation using a carve-out. Under any such scheme, the host’s ex ante expected payout is less than it would be under a strict compensation rule. If the elasticity of the CDF of the tribunal’s observation error is a decreasing function of the realized error, then further broadening an already existing carve-out always decreases the host’s expected payments. This condition always holds for some distributions, and it holds for sufficiently large observation shocks for other distributions.

### 5 Investment

In this section we adapt the linear compensation function ubiquitous in the Takings literature and adapt it to satisfy condition (5). Throughout this section’s analysis we assume the investor is non-strategic, i.e. she takes the probabilities of regulation and compensation as exogenous; Section 6 offers a limited analysis of the efficient compensation scheme when the investor is strategic.

Let \( 1 - \tilde{F} \) and \( \tilde{R} \) denote the ex ante probabilities of regulation and compensation. When the investor is non-strategic she views \( \tilde{F} \) and \( \tilde{R} \) as parameters. The firm’s expected profits are

\[
\tilde{F}\pi(k) - r k + \tilde{R}\theta(k)
\]

and the firm’s first order condition for investment is

\[
\tilde{F}\pi'(k) + \tilde{R}\theta'(k) = r. \tag{10}
\]

\(^{15}\)The Beta density is \( \eta^{v-1}(1-\eta)^{w-1} B(v,w) \), where \( v \) and \( w \) are positive parameters, with \( E\eta = \frac{v}{v+w} \). The constant mentioned in Remark 8 is \( \frac{v}{v+w} \).
The probability that the court rejects the policy powers defense must be positive; otherwise, the host would regulate even when it is not socially optimal to do so. Therefore, $\hat{R} > 0$. This inequality, and comparison of equation (10) with equation (1) shows that the former produces $k^*$ if and only if

$$\theta'(k^*) = 0.$$  \hspace{1cm} (11)

We emphasize the linear compensation scheme (as in BRS):

$$\theta(k) = \delta \pi(k) + \gamma rk.$$  \hspace{1cm} (12)

For the linear compensation

$$\theta'(k^*) = -\delta c_k(q(p(k^*)), k^*) + \gamma r = -\delta c_k - \gamma c_k F^* = - (\delta + \gamma F^*) c_k,$$

where the second equality uses equation (1). Setting this expression equal to 0 gives the condition

$$-\gamma = \frac{\delta}{F^*},$$

so this compensation scheme reduces to

$$\theta(k) = \frac{\delta}{F^*} (F^* \pi(k) - rk).$$  \hspace{1cm} (13)

The linear compensation is a subsidy equal to a multiple $\frac{\delta}{F^*}$ of the expectation of gross profits absent the compensation. Subject to notational translation, this is identical to Theorem 2 in BRS; assuming state contingent consumption contracts and independence of regulation and investment levels, they show that efficient compensation is a scalar of the ex ante (expected) profits of the at-risk firm. Under this linear scheme, the firm’s expected profits (including compensation) are

$$F^* \pi + \frac{(1 - F^*) \delta}{F^*} (F^* \pi - rk) - rk = \left(1 + \frac{(1 - F^*) \delta}{F^*}\right) (F^* \pi - rk).$$

In summary, we have

**Remark 9** The only linear compensation scheme that induces efficient investment for the domestic firm is equivalent to an ad valorem subsidy of $\frac{(1 - F^*) \delta}{F^*}$ on expected profits; this policy is a tax if $\delta < 0$.

Pairing (5) with (13), the carve-out is

$$\hat{\chi}(k) = S(k) \phi(k; \delta)$$ with $\phi(k; \delta) \equiv G^{-1}\left(\frac{F^* \pi}{\delta (F^* \pi - rk)}\right) = G^{-1}\left(\frac{\pi}{\theta}\right).$  \hspace{1cm} (14)
Thus, under the linear compensation scheme with carve-out, there is a one-parameter family of rules, indexed by \( \delta \), that induces the efficient level of investment and regulation.\(^{16}\) The court rejects the police powers defense if and only if its estimate of harm, \( H\eta \), is less than \( \phi \left( k \right) S\left( k \right) \). If the court rejects the police powers defense, the firm receives a fraction \( \frac{\delta}{\tau r} > 1 \) of its expected gross profits absent compensation, \( F^*\pi - rk \). The compensation depends on gross profits (i.e. inclusive of investment costs) rather than variable profits.

How does this compensation rule compare to those proposed elsewhere in the Takings literature and international and domestic law? NAFTA’s Chapter 11 stipulates that “[c]ompensation shall be equivalent to the fair market value of the expropriated investment immediately before the expropriation took place”.\(^{17}\) That is, NAFTA requires “strict” compensation which depends only on variable profits and ignores sunk costs. However, like BRS we find that strict compensation would be distortionary: unless compensation is lump sum or proportional to the investor’s objective function absent compensation, it will induce inappropriate investment levels.\(^{18}\)\(^{19}\) Conversely, Miceli and Segerson’s Ex Post rule mandates strict compensation, a result that is sensitive to the information environment. In their model the courts can perfectly observe social benefits and costs from a taking, and so they will award compensation only when a taking is inefficient. Anticipating this, regulators will only regulate/take a project when it is socially efficient, and thus compensation is never paid in any states of the world; using our notation, under Miceli and Segerson’s Ex Post rule, with perfect information the firms’ expected payoffs are \( F^*\pi - rk \), and so investment is efficient. In our model with asymmetric information, the ex ante probability of compensation must be positive, i.e. \( R > 0 \), otherwise the host will regulate too often. With \( R > 0 \), under strict compensation the firm’s ex ante expected profits would equal \( \left[ F^* + R\right]\pi\left( k \right) - rk \), which will lead to over-investment.

### 5.1 Size of the transfer

Naturally we wonder how large is the implicit transfer \( T \). Remark 9 indicates it is proportional to expected profits absent compensation. We offer a simple illustrative example to show how \( T \) varies with the size of the carve-out. In what follows we restrict attention to equilibrium behavior (thus dropping \( k \) as an argument) and to the family of carve-out/compensation schemes satisfying (13) and (14). Further, we treat \( \theta \) as the

\(^{16}\) Of course not all \( \delta > 0 \) will do; the condition \( \theta > \pi \) necessitates \( \delta > \frac{F^*\pi(k^*)}{\pi(k^*) - \tau r k} \).


\(^{18}\) In some cases distorting investment choices might be desirable. Consider the case where damage equals \( HH(k) \) where \( H \) is a random variable and \( h'(k) > 0 \). In this case, there is an externality associated with investment that investors will ignore even if regulation is efficient and compensation is lump-sum. However, for this problem a simple investment tax is sufficient. It is straightforward to show that a first-period capital tax \( \tau^* \equiv h'(k^*) \int_0^{h(k^*)} H f(H) dH \) induces efficient investment when paired with the following compensation scheme: \( \theta(k) = \frac{\lambda}{\tau^*}[F^*\pi(k) - \left( \tau + \tau^* \right) k] \) and \( \chi(k) = S\left( k \right)\phi \left( k; \delta \right) \) with \( \phi \left( k; \delta \right) \equiv G^{-1} \left( \frac{F^*\pi}{\pi(k^*) - \tau r k} \right) \). Notably, the efficient investment tax is independent of \( \beta \).

\(^{19}\) Unlike BRS, under our compensation rule there will be states in which regulation (a taking) occurs but the investor receives no compensation.
policy parameter and so $\chi$ is implicitly defined as a function of $\theta$ according to equation (14).

Choose units so that $\pi^* = 1$, so the condition $\theta > \pi^*$ (by Remark 2) implies $\theta > 1$. The implicit transfer to an investor under compensation level $\theta$ is

$$T(\theta) = \theta \int_S^\infty G \left( \frac{G^{-1} \left( \frac{1}{\theta} \right) S}{H} \right) f(H) dH.$$  \hspace{1cm} (15)

We noted that when the observation error is exponentially distributed, a larger carve-out decreases the host’s expected payment. In order to get an idea of the order magnitude of this effect, we consider the case where both the damage parameter $H$ and the observation errors are exponentially distributed. Let $g(\eta) = e^{-\eta}$ (so that $E\eta = 1$) and $f(H) = \lambda e^{-\lambda H}$, so $EH = \frac{1}{\lambda}$. For this specialization, we have $G^{-1} \left( \frac{1}{\theta} \right) = -\ln \left( \frac{\theta - 1}{\theta} \right)$. Using this relation we have

$$R \left( SG^{-1} \left( \frac{1}{\theta} \right) \right) = \int_S^\infty G \left( \frac{-S \ln \left( \frac{\theta - 1}{\theta} \right)}{H} \right) \lambda e^{-\lambda H} dH = \int_S^\infty \left( 1 - \exp \left( \frac{S \ln \left( \frac{\theta - 1}{\theta} \right)}{H} \right) \right) \lambda e^{-\lambda H} dH,$$

so

$$T = \theta \int_S^\infty \left( 1 - \exp \left( \frac{S \ln \left( \frac{\theta - 1}{\theta} \right)}{H} \right) \right) \lambda e^{-\lambda H} dH.$$ \hspace{1cm} (16)

The model has two primitive parameters, $S$, the social surplus at the efficient level of investment, and $\lambda$, the hazard rate for damages, and one policy variable, $\theta$. From Proposition 3 and Remark 8 we know that $T$ is a decreasing function of $\theta$. From equation (16) we know that as $\theta \to 1^+$, $R \to 1 - F^*$, i.e. the court never accepts the police powers defense, so the host compensates whenever it regulates. As $\theta \to \infty$, using l’Hôpital’s Rule we have $T \to \int_S^\infty \left( \frac{S}{H} \lambda e^{-\lambda H} \right) dH$. Although this integral does not have a closed form expression, it is useful for our numerical example.

**Example 2** Suppose that $S = 2$ and $\lambda = 1.15$. In view of the normalization $\pi^* = 1$, the choice $S = 2$ means that consumers and the firm share equally in the social surplus (given the efficient level of investment). The choice $\lambda = 1.15$ means that $F^* = 0.89974$, i.e. there is approximately a 10% chance of regulation. From the comments above, the upper bound on $T$ (as $\theta \to 1^+$) is $1 - 0.89974 = 0.10026$ and the minimum value (as $\theta \to \infty$) is $\int_S^\infty \left( \frac{S}{\Pi} \lambda e^{-\lambda H} \right) dH = 0.0748$.

Figure 2 shows the expected transfer as $\theta$ ranges between $1 + 10^{-8}$ and 7. Over this interval, $T$ falls from 0.10025 to 0.076, close to the theoretical max and min. The firm’s expected variable profits + compensation payments ($F^* \pi + T$) range from 0.99999 to 0.97574. Expected consumer surplus less compensation payments ($F^* (S - \pi) - T$) ranges from 0.7995 to 0.8237. Compare this to the case where
Figure 2: Expected transfer as a function of $\theta$ for the exponential model with $S = 1$ and $\lambda = 1.15$. 
regulation is efficient but there is no compensation paid—as would be efficient if \( \beta = 1 \) and \( \theta = 0 \)—and so the firm’s expected variable profits are 0.9. Compensation reduces the value of consumer surplus minus compensation payments by 8.4% to 11% while the investor’s rent rises by an equal percentage. These amounts bound the percentage chance of efficient regulation, 10%.

Particularly noteworthy is the observation that \( T \) does not approach zero as the carve-out is infinitely broadened (i.e. as \( \theta \to \infty \)). This means that, in this example at least, even the broadest carve-out scheme still involves an expected transfer to the investor.

### 5.2 Entry Problem

A compensation scheme that implicitly transfers rents to risky industry raises a familiar concern: when industry size is endogenous, compensation schemes will induce inefficiently high entry. In the appendix we extend the model to include a 0th stage in which a continuum of entrants with increasing entry costs decide whether to enter the industry. We show that offering investors some chance of being compensated for regulatory takings raises their expected returns from entering an industry in the first place. This induces some firms to incur the fixed costs associated with entry even though the expected social return from their entry is negative. Compensation payments induce inefficiently large industries as a result. We show that reducing \( T \) when \( T \) is positive to begin with unambiguously raises social welfare.

A first step toward solving the entry problem is to reduce the size of the transfer implicit in a compensation scheme. Although we cannot guarantee that broadening a carve-out always reduces \( T \), Proposition 2 verifies that \( T \) is always smaller when there is some carve-out rather than none.

This is a useful juncture to point out that making takings compensable only for a subset of entrants isn’t necessarily welfare improving. We make this rather obvious point only because compensation rules in IIAs such as NAFTA’s Chapter 11 do precisely this: only foreign investors are entitled to (possible) compensation for future government actions “tantamount” to expropriation. This tilts the playing field in favor of foreign firms. This isn’t merely “unfair”; with endogenous entry it’s likely inefficient. Consider the following scenario. Firms of a particular nationality are heterogeneous, differentiated by their fixed costs of entry. Firms of all types are rival in that they are linked through the output market. Absent compensation rules and presuming ex post efficient regulation, we would expect the market would sort out firms, with high fixed-cost firms of either nationality abstaining from entry. However when only foreign firms are entitled to compensation, foreign firms that choose to enter the market effectively receive a subsidy on their ex ante variable profits. It would be straightforward to show that this subsidy would cause some high fixed cost foreign firms to enter the market (firms that would otherwise abstain), crowding out some relatively more efficient domestic producers. This outcome exhibits both too much entry and allocative efficiency in which some of the wrong firms enter.
Concern that governments will actively tilt domestic playing fields to the disadvantage of foreign investors/firms is the prime motivator for National Treatment rules. Loosely, National Treatment rules stipulate that governments may not treat foreign goods/investors/firms any less favorably than their domestic counterparts in like circumstances; National Treatment rules appear in almost all modern trade and investment treaties. Our analysis suggests the National Treatment and current Expropriation clauses are contradictory: the latter causes domestic and foreign investors to be in “unlike circumstances”, but the former does not recognize this induced difference. We do not advocate National Treatment rules be dropped, nor do we advocate that all investors be entitled to compensation for regulatory takings. Instead, the modest goal of this paper is show that granting a PPCO for environmental and other public regulations from compensation rules can induce efficient regulation and firm level investment; a PPCO can also provide some relief from the entry and level playing field problems inherent in expropriation/compensation rules.

We would be remiss if we did not discuss alternate solutions to the entry and level playing field problems. If entrants were charged an up front “right of establishment” fee equal to $T$ then the compensation scheme would be self-financing in expectation and offer a net expected subsidy of zero. However we believe introducing up front taxes creates its own moral hazard problem. If the regulator/host government is free to set the tax as it chooses, it will choose a tax greater than $T$ so as to capture rents for the state at the expense of producer surplus foregone by unenfranchised investors. Moreover, up front access fees cannot be used as solution to the level playing field problem created by NAFTA and other IIAs: charging foreign (but not domestic) firms a fee for the right to establishment would clearly violated National Treatment rules.

6 Strategic Investors

Like many before us, we assume investors are non-strategic in our baseline model. This section relaxes this assumption and assumes investors perceive the probabilities of regulation and compensation as endogenous. In the analysis to follow we restrict attention to a representative investor who has already chosen to enter the industry.

A strategic investor chooses $k$ to

$$\max_k F(S(k))\pi(k) - rk + \theta(k)R(k)$$

where $R(k)$ is as defined by (6). Differentiating with respect to $k$ and rearranging gives the first order
condition

\[
\begin{align*}
F(S(k))\pi'(k) - r + \left[ \pi(k) - \theta(k)G \left( \frac{\chi(k)}{S(k)} \right) \right] f(S(k))S'(k) \\
+ R(k)\theta'(k) + \int_{S(k)}^{\infty} G' \left( \frac{\chi(k)}{H} \right) \frac{\chi'(k)}{H} f(H)dH = 0.
\end{align*}
\]

If regulation is ex post efficient then by (5) the collection of terms denoted “b” equals zero. Similarly, the collection of terms denoted “a” equals zero at the socially efficient level of investment \( k^* \).

**Remark 10** Any scheme \( \{ \theta(k), \chi(k) \} \) satisfying equation (5) and the following conditions will induce efficient firm level investment:

C1. \( \Delta(k) = 0 \) when evaluated at \( k^* \)

C2. \( \Delta'(k) \leq 0 \),

where C2 ensures the investor’s objective function is concave.

For example, if the adjudicator knows \( \pi(k^*) \) and \( S(k^*) \) then fixing \( \chi(k) = \bar{\chi} \) for all \( k \) and offering lump sum compensation

\[
\theta(k) = \frac{\pi(k^*)}{G \left( \frac{\bar{\chi}}{S(k^*)} \right)} \quad \forall k
\]

induces efficient regulation and firm level investment. This solution, though, presumes a lot of knowledge on the part of the arbitrator—she must be able to calculate \( \pi \) and \( S \) at the efficient level of investment. But if she has this knowledge then it seems just as reasonable to assume she can deduce \( k^* \) itself and impose the rule “no compensation unless \( k = k^* \)” as per Miceli and Segerson’s Ex Ante Rule (1994).

Assuming the arbitrator has this level of knowledge is consistent with our analytic framework; only \( H \) is private information in our model. As a practical matter, though, learning the shape of \( \pi(k) \) and \( S(k) \) may be very costly for the courts. A PPCO-compensation scheme that relies on market signals—equilibrium values of \( \pi \) and \( S \)—alone is preferable.

Another issue, this one emerging from the legal discourse surrounding carve-outs, is whether the the carve-out should be absolute. In our notation, this is the constraint \( \chi'(k) = 0 \).

Using Remark 10, \( \chi' = 0 \) entails \( \theta'(k^*) = 0 \). Differentiating \( \theta(k) \) under condition (5) gives \( \theta'(k) = \frac{-c_k}{c^*} \left[ 1 - \frac{\pi(k)}{S(k)}/\mu \left( \frac{\bar{\chi}}{S(k)} \right) \right] \). Thus \( \theta'(k) = 0 \) at \( k^* \) if and only if

\[
\frac{\pi(k^*)}{S(k^*)} \mu \left( \frac{\bar{\chi}}{S(k^*)} \right) = 1.
\]

(17)
As (17) holds over a set with measure zero, we conclude the following.

**Remark 11** Fixing the carve-out at a constant value and basing compensation on market information generally leads to inefficient firm level investment when investors are strategic.

In sum, even though a carve-out/compensation scheme may exist that induces both efficient regulation and firm level investment by strategic investors, except possibly in a knife-edge case (of measure zero) it will not involve a fixed carve-out if the courts must rely on market information.

## 7 Conclusion

There is a valid efficiency argument for making regulatory takings compensable. When regulators suffer fiscal illusion, compensation requirements force them to internalize costs borne by investors and property owners. Compensation is thus a tool for inducing efficient regulation.

However compensation also distorts investment and entry decisions. As noted by Blume et al. (1984), basing compensation on market value effectively insures investors against states of the world in which regulation is socially optimal. Even when compensation packages are lump-sum they still serve as an implicit subsidy to at-risk industry, generating inefficiently high entry.

This paper shows that a carve-out—a standing exclusion from compensation rules—for environmental and other public regulations can be designed that induces efficient regulation; when paired with an appropriate compensation package, the resulting carve-out/compensation scheme also induces efficient firm level investment by non-strategic investors.

We explore properties of such a carve-out/compensation scheme. The court must be prepared to reject the police powers defense in order to discourage excessive regulation. As a result, there will be states of the world in which the court commits a type-II error and the courts order compensation even though they know that in equilibrium regulation is socially efficient.

Moreover, when the police powers defense is rejected the regulator must pay damages exceeding investor losses. This reflects a standard result in the enforcement literature: if the probability a cheater goes unpunished is positive, then when she is caught the punishment must be larger than the crime. In our model, however, the regulator’s probability of being caught is private information. Consequently, our carve-out/compensation scheme only equates expected payouts and lost profits at a particular margin, i.e. when realized harm equals pecuniary benefits from the investment project and so social welfare is identical with and without regulation. We show that this structure renders the relationship between carve-out breadth and the implicit transfer to industry non-monotonic for some noise distributions. This notwithstanding, we show that offering some carve-out, as opposed to none, reduces the transfer and so mitigates the entry problem.

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20 I.e. a scheme satisfying (5) and conditions C1. and C2.
At a minimum, our analysis constitutes an efficiency argument in favor of explicitly recognizing a police powers carve-out for regulation designed to protect public health, safety and the environment.

References


**International Centre for Settlement of Investment Disputes**, “Metalclad Corp. v. United Mexican States (Award), ICSID Case No. ARB(AF)/97/1 para. 103 (Aug. 30, 2000),” 2000.


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Appendix: Relationship between $T$ and social welfare when entry is endogenous.

In this appendix we append a 0th “entry” stage to the model and resume our assumptions that compensation satisfies $\theta'(k) = 0$ (as detailed in section 5) and that firms are non-strategic, i.e. they take the probabilities of regulation, $F$, and compensation, $R$, as exogenous.

Suppose there is a continuum of potential entrants uniformly distributed over the unit interval and indexed by $n$. Let $I(n)$ denote the fixed cost of entry for firm $n$; to make things simple we assume $I$ is continuously differentiable in $n$ and order firms so that $I'(n) > 0$. Let $\bar{n}$ identify the firm just indifferent between entering and not in equilibrium; $\bar{n}$ also measures the fraction of potential entrants who actually enter the industry in equilibrium.
We continue to assume firms are atomistic in input and output markets and define \( q \) and \( k \) as per firm output and variable investment; we assume the variable cost function \( c(q, k) \) is identical across firms. We further assume marginal cost \( c_q \) is increasing in \( q \). Thus, for all entrants variable investment and output supply decisions are identical and respectively satisfy \( r = -c_k(q, k) F \) and \( p = c_q(q, k) \) where \( p \) is the equilibrium price which satisfies the goods market equilibrium condition \( Q(p) = nq \) in which \( Q(p) \) is aggregate demand. Although we take \( r \) as exogenous, equilibrium price will clearly depend on the level of entry and so we can write all equilibrium values as functions of \( \bar{n} \): \( p(\bar{n}), q(\bar{n}), k(\bar{n}) \).

Define

\[
W(\bar{n}) = F(S(\bar{n})) S(\bar{n}) - \bar{n} r k(\bar{n}) X + \int_0^{S(\bar{n})} H f(H) dH - \int_0^{\bar{n}} I(n) dn
\]

as aggregate social welfare, where

\[
S(\bar{n}) = \int_0^{q(\bar{n})} p(Q) dQ - \bar{n} c(q(\bar{n}), k(\bar{n})).
\]

This welfare measure implicitly assumes harm \( H \) is independent of the number of entrants; compensation payments and receipts do not appear in \( W(\bar{n}) \) as they are transfers from a social welfare perspective.

Note, this rule reflects regulation that is ex post efficient and satisfies the rule “regulate if and only if \( H > S(\bar{n}) \), or, equivalently, \( H > S(\bar{n}) \)”.

Differentiating \( W \) with respect to \( \bar{n} \) gives

\[
\frac{dW}{d\bar{n}} = F(S(\bar{n})) [pq - c] - rk - I(\bar{n})
\]

Thus the marginal effect of entry on social welfare is merely the difference between the marginal entrant’s expected variable costs and her investment costs. This is negative whenever \( T > 0 \), since the marginal entrant’s fixed costs satisfy \( I(\bar{n}) = F(S(\bar{n}))[pq - c] - rk + T \). Because reducing \( T \) inhibits entry\(^{21}\), broadening the carve-out unambiguously raises welfare whenever equation (9) holds.

\(^{21}\)To verify, examine the expected payoff of the marginal entrant:

\[
F + \int_S^\infty \frac{G(x/H)}{G(x/S)} f_H(H) dH [pq - c] - rk - I(\bar{n}),
\]

which is zero in equilibrium. Now consider an increase in the breadth of the carve-out. Holding \( \bar{n} \) constant, when (9) holds then broadening the carve-out reduces \( \int_S^\infty \frac{G(x/H)}{G(x/S)} f(H) dH \), rendering the marginal entrants expected payoff negative. She will choose not to enter.