# Harmful, Harmless, and Beneficial Uncertainty in Law

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This article offers a model investigating the impact of four types of law-related uncertainty on the utility of risk-neutral agents. We find that an increase in legal or factual uncertainty makes agents worse off if enforcement is targeted (meaning that greater deviations from what the law demands lead to a greater probability of enforcement), or if sanctions are graduated (meaning that greater deviations from what the law demands result in higher sanctions). In contrast, agents are indifferent to increases in uncertainty related to the chance of detection or the size of the sanction. Finally, risk-neutral agents benefit from greater legal uncertainty if they act only upon a preapproval by a cautious regulator. Our findings shed light on numerous policy debates ranging from the appropriate specificity of accounting standards to the corporate criminal liability reform and the government's preference for secrecy about the details of tax law and tax enforcement.

## 1.    Introduction

Few things are certain in life, and the legal system is not one of them. In a perfectly certain world, all laws would be clear, their application to the facts in each case would be unambiguous, as would be the facts themselves, all violations would be detected and punished, and sanctions would be fixed and known to everyone in advance. The reality, of course, is very different.

We investigate how various types of uncertainty that exist in every legal system affect utility of risk-neutral agents. The answer turns out to be more complicated than expected. Before explaining our results, we begin by recognizing that uncertainty in a legal system has many causes.

To start, law itself is often vague. Think of the reasonable person standard in torts, the entire fairness standard in corporate law, the due process standard of the U.S. Constitution, or such common legal terms as primary, significant, substantial, principal and the like. Every time the law uses these and similar ambiguous formulations, every time it relies on a standard rather than a rule, law's subjects face legal uncertainty. They cannot be sure about the precise meaning of the law.

Even if the law is perfectly clear, its application to a particular set of facts is frequently uncertain. A speed limit may be set at precisely 60 miles per hour, but police radar guns may err, police officers may make mistakes in reading their radar guns, car speedometers may be miscalibrated or defective, eye witnesses may be confused, records may be lost or mixed up, and so on. All these are examples of factual uncertainty. Just like legal uncertainty, factual uncertainty is endemic and unavoidable in any legal system.

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Legal and factual uncertainty are obviously important, but detection uncertainty may be the one most familiar. Not all speeding drivers get a ticket, not all parking violations are detected, not all tax returns are audited (and not all tax evasion is detected on audit), and even the most serious crimes occasionally go unresolved.

Finally, punishment is rarely fixed in advance. Tort damages depend on the magnitude of harm that is rarely known until after the harm occurs. Contract damages are often speculative until the contract is breached. Fines for many statutory violations exhibit breathtakingly wide ranges, such as from 100% to 300% of gain from insider trading (Securities Exchange Act 1934, sec.78u-1(2)). And even though criminal sanctions are specified by a precise, elaborate grid, plenty of uncertainty remains. The grid prescribes fairly wide ranges (U.S. Sentencing Guidelines Manual 2015, ch. 5) that are not binding on courts in any case (United States v. Booker 2005). All these are examples of sanction uncertainty. Without purporting to offer a comprehensive list, we investigate how legal uncertainty, factual uncertainty, detection uncertainty, and sanction uncertainty affect utility of risk-neutral actors in various enforcement environments.

The first such environment is targeted enforcement. Regulators, prosecutors, and private plaintiffs (or their lawyers) do not pursue all possible violations with equal zeal. Instead, they tend to target their efforts at the most egregious transgressions—acts that reveal the lowest effort to comply with the law by the regulated party. Such targeting may occur because more egregious violations are easier to prove in court, because they produce greater recoveries if sanctions are graduated, because they offend the enforcers' sense of justice, or for some other reason.[1] We are not the first ones to suggest that targeted enforcement reflects many real-world regulatory regimes (Craswell 1999, Craswell and Calfee 1984, Lemos and Stein 2010, Osofsky 2014, Stigler 1970, Wu 2009, Young and Myles 2016).

Second, sanctions may rise as behavior increasingly deviates from the line separating legal and illegal conduct. Tort law imposes punitive damages for particularly egregious acts (Sharkey 2013). Tax law and environmental law impose higher statutory penalties for increasingly aggressive violations (Raskolnikov 2014). And we all know what happens to fines when drivers exceed the speed limit by a greater margin. We will refer to this feature of sanctions as aggressiveness-based graduation (or graduation for short).[2]

Our model shows that increases in legal or factual uncertainty make risk-neutral agents worse off if enforcement is targeted or if sanctions are graduated. Take targeted enforcement of an uncertain legal standard as an example. Targeted enforcement creates an asymmetry in payoffs after the uncertainty is resolved. If the regulator (or some other law enforcer) concludes that an agent complied with the law, the agent is not sanctioned. Notably, it makes no difference whether the agent barely cleared the compliance threshold or took an unassailable position. If, however, the agent is found to violate the

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[1] Note that targeted enforcement is possible only if enforcement is uncertain. If all detected violations are pursued by private or public enforcers, there is nothing to target. But such comprehensive, universal enforcement is unrealistic. When it does not occur, targeted enforcement is both possible and plausible.

[2] It is important to remember that sanctions can be, and often are, graduated in many ways other than based on aggressiveness (Raskolnikov 2016).

law, it matters whether the violation is slight or egregious. Greater legal uncertainty (in the mean-preserving spread sense) makes any given violation more likely to be egregious. This increases the chance of a sanction when enforcement is targeted, harming the agent. To be sure, greater uncertainty also makes any given compliance effort more likely to be unassailable—to exceed what the law requires by a wide margin. This, however, yields no benefit for the agent.

Given this asymmetry, a rational agent might respond to an increase in uncertainty by slightly increasing or decreasing its compliance effort (as is well-known since Craswell and Calfee (1986), and Shavell (1987)). But because the original position was optimal, the benefit from this slight change is second order. In contrast, the increased chance of regulator's disapproval has the first-order effect of reducing the agent's payoff. Thus, we should not be surprised when large, well-advised, sophisticated corporations not only lobby government agencies to clarify vague legal standards, but are willing to accept less advantageous rules as long as the rules are clear, as discussed below. The analysis is similar if the uncertainty is factual rather than legal, and if the enforcement is not targeted but sanctions are graduated.

On the other hand, we show that the agent is indifferent to changes in uncertainty related to the chance of detection or the magnitude of sanctions. Thus, combining legal, factual, and detection uncertainty into a single "probability of liability" variable, as has been done in law enforcement models since the foundational paper by Becker (1968), is likely to obscure the varying effects of different types of uncertainty in law.

The analysis changes if neither targeted enforcement nor graduated sanctions are present. In this basic enforcement environment, an increase in legal or factual uncertainty has an ambiguous effect on the agent's utility. This ambiguity has the same cause as the well-known ambiguity of the agent's compliance efforts identified by Craswell and Calfee (1986) and Shavell (1987).

Our final inquiry examines the impact of uncertainty on agents who must obtain a preapproval from a regulator who is cautious in interpreting an uncertain legal command. An agent may request a preapproval because the relevant legal standard is vague and the agent may wish to avoid legal uncertainty. Or the legal command may appear clear but the agent may request an exception from the rule that is arguably justified by some higher-order principle, such as the rule's "spirit" or the "public interest" (Standard State Zoning Enabling Act 1926). Think of an application for a zoning variance, an SEC no-action letter, or a Private Letter Ruling from the IRS. A preapproval request may be mandatory (zoning variance) or optional (no-action letter), but without it the desired action will not take place.

We posit that a regulator considering a request is more likely to grant a preapproval if the proposed action satisfies the relevant legal standard easily.[3] We show that when the

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[3] A regulator may adopt this cautious preapproval strategy to avoid regretting its permissive interpretation later on, to acquire more information about the relevant behavior, to avoid making a close call, or to make a later judicial reversal less likely (the judicial challenge may come, for instance, after a regulator approves a

regulator allocates preapprovals cautiously, the agent prefers greater legal uncertainty. The result here is the inverse of the targeted enforcement case. The regulator never approves agent's compliance efforts that fall short of the legal standard. Even if the compliance effort exceeds the standard but barely so, the regulator is likely to reject the request. But when the effort greatly surpasses the standard, the regulator grants the preapproval.

The payoff again is asymmetric. The agent benefits—it is more apt to get its action pre-approved—if the regulator determines that the law requires very little. Greater legal uncertainty makes this determination more likely. At the same time, whether the law requires a great deal more or just a shade more compliance than the agent actually proposes is immaterial. Either way, the regulator denies the agent's request. So an increase in legal uncertainty makes no difference to the agent whose request is denied. Overall, the agent gains from more uncertain law.

Like with targeted enforcement, this result holds only if the regulator acts cautiously. If, in contrast, the regulator is equally likely to preapprove any proposed compliance effort that exceeds the regulator's view of what the law demands, the impact of increased uncertainty on the agent's utility is ambiguous.

One may summarize our results by saying that risk-neutral agents may like, dislike, or not care about the law-related uncertainty depending on the circumstances. While true, this summary would be misleading. Few legal regimes are free from both legal and factual uncertainty. If one believes that targeted enforcement is common, one would conclude that risk-neutral agents are often harmed by legal and factual uncertainty. One would also conclude that concerns about sanction uncertainty are less severe.

Our findings have a number of direct policy implications. First, they inform the choice between competing regulatory approaches differing in the levels of specificity of legal commands. The competition between these rules-based and standards- or principles-based approaches has embroiled the Securities and Exchange Commission (SEC) and the Commodities Futures Trading Commission (CFTC) (D'Souza, Ellis and Fairchild 2010), the supporters of the Generally Accepted Accounting Principles (GAAP) and those who favor the International Financial Reporting Standards (IFRS) (Gelter and Eroglu 2014), the Court of Appeals for the Federal Circuit and the U.S. Supreme Court (Olson and Fusco 2013). Our analysis points to one factor that favors more certain legal rules.

Second, our findings suggest that even if the regulator lacks authority to reduce legal uncertainty, the regulator may benefit the regulated parties but reducing the related factual uncertainty—something that the regulator typically has the authority to do.

Third, our results support the relative lack of graduated sanctions in the U.S. legal system despite abundant opportunities to create graduated punishment regimes (Raskolnikov 2014).

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zoning variance (Cohen 1995)). Our numerous conversations with practicing lawyers and former regulators suggest that cautious preapproval (as well as targeted enforcement) are common regulatory strategies.

Fourth, if one were choosing whether to focus a law reform effort on reducing legal or sanction uncertainty (for instance, if one were thinking about reforming the substantive rules and sentencing guidelines for corporate white collar crime), our model offers a strong reason to concentrate the reform effort on making the substantive law less uncertain.

## Related Literature

The most closely related literature studies the effect of uncertainty on optimal deterrence. It does not consider the impact of uncertainty on the payoffs or utility of the regulated parties. Craswell and Calfee (1986) show that the effect of uncertainty on optimal deterrence is ambiguous if the imposition of liability leads to a discontinuous increase in sanctions. They, as well as Kahan (1989), also demonstrate that uncertainty leads to underdeterrence if sanctions increase gradually. Shavell (1987) proves that uncertainty has an ambiguous effect on under- and over-compliance with an exogenously set certain legal threshold. More recently, Dari-Mattiacci (2005) concludes that uncertainty may have ambiguous or unambiguous effect on efficiency given the particular features of tort law.

Our findings neither contest nor elaborate on these results. Sharing with others some skepticism about the degree to which real-world legal regimes may plausibly approximate welfare maximization (Craswell 2003, Niblett, Posner, and Shleifer 2010, Posner 2003, Raskolnikov 2013), and similar to models of tax compliance (Beck and Jung 1989, Scotchmer 1989, Kaplow 1998, Krause 2000), we focus on the effect of uncertainty on actors' utility rather than on social welfare.

Raskolnikov (2017) studies the effect of legal uncertainty on the probability of success and private gains. Relying on simulations, he argues that greater certainty induces agents to take stronger legal positions and tends to increase private gains under certain assumptions. In contrast with our study, he does not model targeted enforcement, cautious preapproval, or graduated sanctions, and does not offer a general solution to his optimization problem. On the other hand, we do not consider the effects of diverging interpretations of ambiguous terms by private actors and the enforcement agency, or the use of the penalty multiplier in conjunction with various types of uncertainty, as he does.

Several tax scholars have focused on the impact of uncertainty on the utility of private actors. Beck and Jung (1989), Scotchmer and Slemrod (1989), Jung (1991), and Kaplow (1998) conceptualize uncertainty as a random variation of taxable income around the mean. Their analyses do not incorporate the agent's effort to comply with the law—our focus here. Beck and Jung (1989), Scotchmer (1989), Kaplow (1998), and Krause (2000) interpret legal uncertainty as the actor's lack of knowledge of the legal consequences. This ignorance may be reduced or eliminated by learning the rules or acquiring legal advice. We focus on legal uncertainty that may not be resolved in this manner. Alm (1988) focuses on uncertainty due to possible future legislative changes. While rational actors are surely aware that legal reforms are possible, they must choose their compliance efforts under the existing law—the choice we investigate here. Krause (2000), Mills et al. (2010), and Graetz et al. (1989) interpret legal uncertainty as we do, but treat the actor's

compliance effort as exogenous. Actors in their models "observe" (Mills et al. 2010, p. 1727) their positions and choose how to act given this observation. In contrast, we investigate how actors choose their efforts given other considerations. Furthermore, no contributions discussed in this paragraph study the targeted enforcement, graduated sanctions, or cautious preapproval regimes.

A number of scholars discuss the enforcement and penalty structures that we use in our model. Craswell (1998) focuses on the interaction of the damages multiplier and targeted enforcement. Lemos and Stein (2010) argue informally that targeted enforcement should increase compliance. Osofsky (2014) takes targeted enforcement as a given and critiques its efficacy. Raskolnikov (2014) investigates when graduated sanctions are likely to be efficiency-enhancing. None of these scholars offer a formal model and none study the effect of varying uncertainty on agent's utility.

Finally, models investigating the incentive or welfare effects of uncertainty in the legal system often combine several types of uncertainty that we study here into a single variable. Becker's (1968) canonical treatment models the "probability of conviction" that includes "the probability that an offense is discovered and the offender apprehended and convicted" (Becker 1968, p. 204).[4] Craswell and Calfee (1986) discuss legal uncertainty, but note that "[u]ncertainty can arise from many sources, ranging from prosecutorial discretion and other enforcement decisions to the manner in which an appellate court eventually interprets a vague statute. Each kind of uncertainty produces a similar qualitative effect" that they identify (Craswell and Calfee 1986, p. 283). More recently, Hoeppner and Lyhs (2016) offer an experimental test of Craswell and Calfee's (1986) findings. Although Hoeppner and Lyhs (2016) consistently refer to their key variable as legal uncertainty, their experiment offers subjects a sliding scale accompanied by a numerical and graphical representation of payoffs corresponding to any chosen position of the slider on that scale. This abstract presentation may reflect every kind of uncertainty that we discuss here. Hylton and Lin (2010) investigate the incentive effects of uncertain enforcement recognizing that "[i]n a more disaggregated model the probability of enforcement [the variable they study] would be broken down into the product of three components: the probability of detection, the probability of an enforcement action, and the probability of liability." (Hylton and Lin 2010, p. 254).[5] Harel and Segal (1999) discuss the efficiency consequences of uncertain sanctions compared to uncertain "sentencing." The probability of sentencing, they explain, includes the probability of detection as well as conviction (Harel and Segal 1999, p.278). Ulph (2009, p. 9) studies the "probability that the tax authority successfully challenge the scheme." He recognizes that this probability "is the product of 3 underlying probabilities" but concludes that he can combine all three in a single variable.[6] In contrast with all these contributions, we

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[4] Importantly, Becker (1968) recognizes that this combined probability is itself uncertain (Becker 1968, p. 177).

[5] The authors suggest that one way of interpreting their model is to assume that enforcement is perfect and legal uncertainty is absent (Hylton and Lin 2010, p.254).

[6] The three probabilities are "that the tax authority investigates the taxpayers; if it investigates, that it discovers the scheme has been used; if it discovers, it successfully demonstrates that the scheme fails and collects all the tax plus interest plus penalties" (Ulph 2009, p. 9).

show that different types of law-related uncertainty have different effects on the utility of agents given the specific features of the enforcement environment that these agents face.

The article proceeds as follows. The next two sections demonstrate the detrimental effects of legal and factual uncertainty on a risk-neutral agent facing a targeted enforcement environment. The following section extends the analysis to graduated sanctions. We then show that detection and sanction uncertainty do not give rise to similar detrimental effects. The last part of the analysis demonstrates that risk-neutral agents benefit from greater legal uncertainty when requesting a preapproval from a cautious regulator. A short conclusion follows.

## 2.1 Legal Uncertainty with Targeted Enforcement

A risk-neutral agent, a firm, operates a business subject to regulation. Throughout the discussion, we will assume that the firm is an animal feeding operation regulated under the Clean Water Act.

Under the Act, if the regulator designates the firm as a Concentrated Animal Feeding Operation (CAFO), the firm is required to obtain a permit and to produce a waste management plan. For small operations, a business is a CAFO if "[t]he appropriate authority … determin[es] that [the business] is a significant contributor of pollutants to waters of the United States" (40 C.F.R. 122.23 (c)).

To avoid designation as a CAFO (and, with it, more invasive regulation), the firm must decide how much to spend on pollution control so as not to contribute "significant" pollutants to the waterways. The firm's compliance effort lies between 0 and 1. For instance, the firm might choose what fraction of waste to capture in an anaerobic lagoon, ranging from capturing no waste to capturing all of it.

Denote the firm's compliance effort by $x$, with an associated cost of $c(x)$. The cost of compliance increases at an increasing rate ($c'(x) > 0$; $c''(x) > 0$; also $c'(0) = 0$ and $c'(x) \to \infty$ as $x \to 1$). If the firm's compliance effort fails to satisfy the legal standard, the firm will have to pay sanction $S$ with certainty. The regulator's interpretation of a "significant contributor of pollutants" standard is unknown: the standard is a source of legal uncertainty.

The standard is a random variable $A$. It can take on values between 0 and 1. For instance, the regulator could decide that a firm capturing 50 percent of the waste in a lagoon is not a "significant" polluter, or 25 percent, or 90 percent. However, the firm realizes that the more waste it captures, the more likely it will avoid the "significant" polluter designation. Denote a specific realization of the random variable (here, the percentage of waste captured) as $a$. Legal uncertainty is distributed according to the distribution $F(a)$, with a strictly positive density $f(a)$.

Assume that the firm benefits from operating the feedlot at its optimal (interior) compliance effort. The firm seeks to minimize its operation cost. This cost is the sum of the compliance cost $c(x)$ and the expected sanction.

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The regulator cares about (1) whether the firm failed to comply with the legal standard and (2) the extent of non-compliance. Specifically, the likelihood of enforcement depends on the distance between the firm's compliance effort $x$ and what the regulator ex post believes the law demands, $a$.[7] This is targeted enforcement.

Given the realization of the legal standard $a$ and the compliance effort $x$, the conditional probability of enforcement is

$$
\begin{array}{ll}
a - x & if\ a > x \\
0 & otherwise
\end{array}
\tag{1}
$$

Taking account of all the possible realizations of the legal standard, if the firm takes compliance effort $x$, the unconditional probability of enforcement is

$$
P(enforcement) = F(x) * 0 + \int_x^1 (a - x)f(a)da
\tag{2}
$$

Anticipating this, the firm selects its compliance effort to minimize the sum of its cost of compliance and the expected sanction, or

$$
c(x) + S \int_x^1 (a - x)f(a)da
\tag{3}
$$

After integrating by parts the second term, the objective function becomes

$$
c(x) + S \int_x^1 (1 - F(a))da
\tag{4}
$$

The first order condition that determines the optimal compliance effort is

$$
c'(x) - S\big(1 - F(x)\big) = 0
\tag{5}
$$

This expression instructs the firm to balance the marginal cost of an additional unit of compliance against its marginal benefit.[8] The marginal benefit is the one unit reduction in the probability of enforcement whenever compliance effort falls short of the legal standard. That value is $1 - F(x)$. The marginal cost is $c'(x)$.

Now consider the change in the firm's payoff from a small (mean-preserving) change in the riskiness of the distribution. Doing so leads to the first proposition.

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[7] Indeed, the EPA notes this as an express practice, stating:

> In those cases where a facility has not been designated as a CAFO but the NPDES permitting authority has identified areas of concern, the authority should note those areas in the letter. The letter should state that if the concerns are not corrected, the facility could be designated as a CAFO in the future.

NPDES Permit Writers' Manual for CAFOs.

[8] The second order condition is $c''(x) + f(x) > 0$, which is satisfied, ensuring that the compliance effort that solves the first order condition identifies a minimum.

***Proposition One****: A firm operating in a regulatory environment with legal uncertainty and targeted enforcement is worse off when uncertainty increases in a way that preserves the mean.*

Proof:

Let $F(a; r)$ be the distribution reflecting legal uncertainty, where $r$ is a parameter that captures the riskiness of the distribution. A mean preserving spread implies that $\int_0^y F_r(a; r)) da > 0$ for all values of $y \in [0,1)$ (see Ljungqvist & Sargent (2012), p. 163). Evaluated at the optimal compliance effort, $x^*$, the firm's total cost of operating the feedlot is

$$c(x^*) + S \int_{x^*}^1 (1 - F(a; r)) da \tag{6}$$

Adding and subtracting $S \int_0^{x^*} (1 - F(a; r)) da$ yields:

$$c(x^*) + S \int_0^1 (1 - F(a; r)) da - S \int_0^{x^*} (1 - F(a; r)) da \tag{7}$$

The second term, $S \int_0^1 (1 - F(a; r)) da = S \int_0^1 a f(a) da$, which is $EA$, the expected value of the legal standard. By the definition of a mean preserving spread, this term does not change when the parameter $r$ changes. As a result, the change in the expected cost is just $S \int_0^{x^*} F_r(a; r)) da$, which is positive under a mean preserving spread. The overall operational cost for the firm increases as legal uncertainty increases ∎

This is a novel result. The standard law-and-economics models of law-related uncertainty do not inquire into the uncertainty's effect on the utility of the affected agents. If, however, a model such as the one offered by Craswell and Calfee (1986) were used to make this inquiry, the result would be different from ours.

To be more precise, Craswell and Calfee (1986) consider a basic enforcement environment without targeting. In their model, if the firm's compliance falls short of the standard, the firm is liable; otherwise it is not. Unlike in the targeted enforcement setting, the amount by which the firm's compliance effort falls short of the standard is immaterial. In this setting, the impact of an increase in uncertainty on firm profit is ambiguous.[9] The ambiguity arises because an increase in uncertainty may increase or decrease the probability of enforcement in the Craswell and Calfee (1986) type model. In contrast, if enforcement is targeted, an increase in uncertainty always increases the probability of enforcement, harming the firm.

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[9] In a Craswell and Calfee (1986) style model, the firm seeks to minimize its compliance costs and the expected sanction, where the sanction is imposed if the amount the law demands exceeds the firm's compliance effort (formally, the firm minimizes $c(x) + S(1 - F(x; r))$). Evaluated at the optimal compliance level, the derivative of the expected cost with respect to mean preserving spread parameter $r$ is $-F_r(x^*)$, a value whose sign is uncertain.

The focus on targeted enforcement leads to a crisp prediction about how firms are likely to view legal uncertainty. In so doing, this result explains preferences of large sophisticated firms that appear puzzling otherwise.

Consider a recent comprehensive survey by a global accounting firm Grant Thornton. The study took place amidst an unprecedented increase in uncertainty of international taxation. The multilateral effort to counter Base Erosion and Profit Shifting (BEPS) brought a "change in paradigm" in international taxation, according to the director of the OECD Center for Tax Policy Administration (Johnston 2015).[10] The greatest international tax planning tool—the ability to shift profits around the globe by aggressively using the so-called transfer pricing—came under a direct threat from the BEPS initiative (GAO p.7-11). As a result, it became clear early on that the BEPS project may require significant changes in international tax planning of multinational enterprises. What exactly these changes would entail remained unclear for some time. It also remained uncertain whether the BEPS project would lead to any multilateral agreement at all.[11]

In this regulatory environment, Grant Thornton queried 2,580 businesses from 35 jurisdictions whether they would accept higher taxes in exchange for a greater clarity from the tax authorities regarding what constitutes acceptable tax planning (Parillo 2015). Three quarters of the respondents answered in the affirmative. This is exactly what our model predicts. Note that our prediction arises from a plausible assumption about enforcement targeting rather than a questionable assumption that major multinational corporations are risk-averse.[12]

Our finding also informs the persistent rules-standards debate that takes place across many regulatory domains. The SEC, for instance, prefers more certain rules (relatively speaking, of course) while CFTC is a proponent of the principles-based regulation (Department of the Treasury 2009). The tension between the two approaches leads to gaps and inconsistencies in the regulation of financial instruments (D'Souza, Ellis, and Fairchild 2010). Which agency should prevail? Our result offers one reason to favor relatively more specific rules. To take another example, the U.S. adoption of the International Financial Reporting Standards has been delayed, in part, due to SEC's concerns that the IFRS would replace relatively clear GAAP rules with relatively vague accounting principles (Gelter and Eroglu 2014). Again, our finding point to one consideration supporting the SEC's reluctance to make the accounting standards more vague.. Regulatory agencies are not the only actors debating the appropriate level of legal

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[10] The project was sponsored by the G20 leaders, and it lead to a publication of a voluminous package of thirteen reports (Johnston 2015). The consultations, proposals, and interim drafts that preceded the issuance of the reports have increased legal uncertainty for businesses worldwide.

[11] More specifically, it was uncertain whether the then governing "arm's length" standard would continue to apply to transfer pricing, and, assuming it would, how the meaning of "arm's length" price would change as a result of the BEPS project.

[12] There are, of course, other reasons why firms may act in a risk averse-manner. Risk-averse managers may impose their personal preferences on the firm. Here risk-aversion is an agency cost. The firm may be liquidity constrained, or may wish to avoid bankruptcy (Stiglitz and Greenwald 1993). We do not dispute any of these explanations. Rather, we show that risk-averse behavior also arises from targeted enforcement (and graduated sanctions) even in the absence of agency costs, or credit constraints, or a bankruptcy threat.

certainty. The U.S. Supreme Court has repeatedly rejected the efforts by the Court of Appeals for the Federal Circuit to make the U.S. patent law more rule-like (Olson and Fusco 2013). Our model offers partial support for the Circuit court's side of the debate.

## 2.2    Legal Uncertainty with Graduated Sanctions

The model offered above accommodates graduated sanctions as well. Suppose that the law is vague (as before), sanctions for noncompliance are imposed with certainty (as before), but enforcement is not targeted. However, the size of the sanction is no longer $S$. Rather, the sanction depends on the distance between the firm's compliance effort $x$ and the effort that the regulator views as required under an uncertain standard, $a$. The more egregious the violation, the higher the fine.  Thus, the firm expects the following sanction

$$
\begin{array}{ll}
(a - x)S & \text{if } a > x \\
0 & \text{otherwise}
\end{array}
\tag{8}
$$

One can see that incorporating graduated sanctions into the model yields the exact same objective function for the firm as the targeted enforcement does.[13] It follows that the mean preserving spread in legal uncertainty harms the firm facing graduated sanctions even if enforcement is not targeted.

Aggressiveness-based sanctions graduation certainly exists. Tort damages (Sharkey 2013), environmental penalties (RCRA Civil Penalty Policy 2003), and tax fines (Raskolnikov 2014) all rise as behavior increasingly deviates from a vague legal threshold. In all these settings greater legal uncertainty harms risk-neutral agents. But graduated sanctions are relatively rare. The Securities Exchange Act's sanction for insider trading all but invites aggressiveness-based graduation (15 U.S. Code sec. 78u-1(2)). Yet the SEC has not accepted the invitation (Laby and Callcott 1994). Many regulatory regimes create elaborate schemes of varying sanctions, yet eschew aggressiveness-based graduation as well.[14] Our model supports these regulatory design choices.

## 2.3    Factual Uncertainty with Targeted Enforcement or Graduated Sanctions

We now turn from legal to factual uncertainty.  The firm running the feedlot has been designated a CAFO and, as a result, must obtain a permit for the firm's waste disposal process. To do so, the firm must develop a "nutrient management plan" (40 C.F.R. 122.42(e)(1)). Failure to comply with the plan can lead to sanctions.

The plan offered by the firm and approved by the regulator specifies the exact level of a particular chemical in the soil.[15] The regulator monitors this level, but the monitoring is subject to error. For example, the regulator might mismeasure the level of the chemical in

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[13] Compare Equation (8) with Equations (1)-(3).

[14] These include the Securities Exchange Act's general sanctions schedule (15 U.S. Code sec. 78u), the U.S. Sentencing Guidelines (U.S. Sentencing Guidelines Manual sec. 2R1.1), and the Criminal Fines Improvement Act's (18 U.S. Code sec. 3571(d), 3572(a)).

[15] Most waste disposal occurs via land application, i.e., taking the waste and applying it to the fields.

a soil sample, or misattribute the test result from one feedlot operator to another. Based on these and similar errors, the regulator might conclude that the firm had violated the nutrient management plan even if in fact the firm complied, or vice versa. Thus, the firm faces factual uncertainty.

As before, the firm wishes to minimize its operation costs (the sum of its compliance costs and the expected sanction). The firm knows that it will be held liable if its compliance effort fails to satisfy a legal command, labeled $a^*$. Notably, $a^*$ is not a random variable in this section but a reflection of a clear rule. In our example, $a^*$ is a specific number—the level of the chemical in the soil sample.

The firm chooses the compliance effort $x$. The regulator observes this effort with error. To model this error, consider a random variable $K$, which is distributed on the interval $[0, \overline{k}]$ according to a distribution $G(k)$ with strictly positive density, $g(k)$. If the firm chooses compliance effort $x$, the regulator observes compliance effort $kx$, where $k$ is the realization of the random variable. The lowest level of observable compliance is zero; the highest is $\overline{k}x$. Following its observation, the regulator decides whether to impose the sanction.[16]

Given an observed compliance level, $kx$ and targeted enforcement, the probability of enforcement is

$$
\begin{array}{ll}
a^* - kx & if \ a^* > kx \\
0 & otherwise
\end{array}
\tag{9}
$$

Summing over all realization of the factual error rate, the unconditional probability of enforcement as

$$
P(enforcement) = \left[1 - G\left(\frac{a^*}{x}\right)\right] * 0 + \int_0^{\frac{a^*}{x}} (a^* - kx) g(k) dk
\tag{10}
$$

The firm sets compliance to minimize

$$
c(x) + S \int_0^{\frac{a^*}{x}} (a^* - kx) g(k) dk
\tag{11}
$$

The next proposition formalizes how factual uncertainty affects the firm's payoff.

***Proposition 2****: A firm operating in a regulatory environment with factual uncertainty and targeted enforcement is worse off when uncertainty increases in a way that preserves the mean.*

Proof:

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[16] By modeling the regulator's error as a multiple of the firm's effort rather than an additive term, as is typically done (Shavell 1987), we avoid the possibility that the compliance effort may be negative. Because $K$ is a random variable, our modeling choice does not establish any particular proportionate relationship between the actual compliance effort and the regulator's observation of that effort.

Parameterize the distribution, $G$, by $r$, whose increase translates into a small mean preserving spread. Integrate the second term of the firm's objective function by parts, yielding

$$c(x) + S \int_0^{\frac{a^*}{x}} G(k; r) \, dk \tag{12}$$

An optimal level of compliance, denoted $x^*$, is determined by the first order condition:

$$c'(x) - SG\left(\frac{a^*}{x}; r\right)\frac{a^*}{x^2} = 0 \tag{13}$$

Evaluated at the optimal compliance, the firm's total compliance cost is

$$c(x^*) + S \int_0^{\frac{a^*}{x^*}} G(k; r) \, dk \tag{14}$$

Differentiation with respect to $r$ yields

$$S \int_0^{\frac{a^*}{x^*}} G_r(k; r) \, dk > 0 \tag{15}$$

completing the proof■

Two further results regarding factual uncertainty mimic those for legal uncertainty. First, if sanctions are graduated, greater factual uncertainty makes the firm worse off. Suppose that the size of the sanction depends on the extent of noncompliance that is observed by the regulator with error, that is, on $(a^* - kx)$. The graduated sanction is given by

$$\left\{ \begin{array}{ll} (a^* - kx)S & \text{if } a^* > kx \\ 0 & \text{otherwise} \end{array} \right\} \tag{16}$$

This expected sanction leads to the same objective function as the one described in Equation (11), and the result of Proposition 2 carries over.

Second, an increase in factual uncertainty has an ambiguous effect on the firm utility in the case without targeted enforcement or graduated sanctions. The reason is the same as the one discussed in connection with legal uncertainty: greater factual uncertainty may increase or decrease the probability of enforcement.

Even though our model yields similar results for legal and factual uncertainty, some of the policy implications differ. On the one hand, lawmakers may be in a position to choose among several regulatory approaches with varying factual uncertainty. This is similar to the choice between rules-based and standards-based regulation discussed above. On the other hand, a regulator lacking authority to reduce legal uncertainty may have authority to diminish factual uncertainty. We illustrate these points in turn.

A regulator may have a choice between alternative legal commands that involve different levels of factual uncertainty. Consider the choice between design and performance

standards in environmental law. Generally, performance standards are considered preferable because they encourage technological innovation (Revesz and Kong 2011). In enacting the Clean Air Act, for example, Congress indicated a "strong preference for numerical emission limitations," Adamo Wrecking v. United States (434 U.S. 275, 289 [1978]). At the same time, the Act permits the EPA to enact design standards when "it is not feasible … to prescribe or enforce an emission standard." (42 U.S. Code sec. 7412(h)(1), 434 U.S. at 286). This feasibility exception is typically interpreted to apply when "it is very difficult (or even impossible) to measure the pollution being emitted" (Revesz and Kong 2011, p. 1597). Our analysis suggests that the meaning of "feasibility" should also include settings where measurements required by a performance standard are error-prone.

Even if a regulator has no authority to choose the type of legal command, the regulator may reduce factual uncertainty.  Tax law, to take one example, is full of provisions that base consequences on the share of the assets retained or transferred by a firm. For instance, some corporate reorganizations turn on whether the firm transfers "substantially all" of its assets (Internal Revenue Code, sec. 368(a)(1)(C)). Other transactions must satisfy specific percentage tests (Internal Revenue Code, sec. 851(b)(3)). The "substantially all" test is vague, the specific percentage test is precise, but both require asset valuation.  Needless to say, valuation is subject to error and disagreement. While the Internal Revenue Service has no authority to change statutory tests like the ones just described, it may—and does—issue regulations clarifying the details of valuation measurements (Treasury Regulation, secs. 1.412(c), 1.471-4, 1.482-6 and numerous other sections). Our result suggests that to the extent that these clarifications reduce factual uncertainty, they benefit regulated firms.

## 2.4    Sanction Uncertainty and Detection Uncertainty

To investigate detection and sanction uncertainty, let us continue with our motivating example. The EPA and its state counterparts operate an inspection program to ensure compliance with the Clean Water Act. According to the EPA,

> [The EPA] might inspect your operation because it was the subject of a citizen complaint or tip, because it was randomly selected, or because it was targeted for inspection based on your state's targeting method. EPA and the state permitting authorities conduct two main types of inspections at AFOs: 1. Inspections that help to decide whether a facility is a CAFO and should have a permit. 2. Inspections to determine whether a permitted CAFO is in compliance with its NPDES permit (EPAs, Producer's Compliance Guide for CAFO's).

Suppose our firm became a "permitted CAFO" and is now facing possible inspections to determine the firm's compliance with its permit containing some vague language. The rate of inspection is initially unknown. Assume that with probability .5, the inspection rate is high, denoted by $r^h$; and with probability .5 the inspection rate is low, denoted by $r^l$. If inspection occurs, the probability of enforcement by the regulator is

$$P(enforcement) = F(x) * 0 + \int_x^1 (a-x)f(a)da \qquad (17)$$

This is the same expression as Equation (2). It represents the probability of prosecution with targeted enforcement of a legal standard. With detection uncertainty, the firm minimizes

$$c(x) + S\frac{1}{2}r^h \int_x^1 (a-x)f(a)da + S\frac{1}{2}r^l \int_x^1 (a-x)f(a)da \qquad (18)$$

Or

$$c(x) + SEr \int_x^1 (a-x)f(a)da \qquad (19)$$

where $Er$ is the expected inspection rate. To minimize its operational costs, the firm's compliance decision must satisfy the first order condition:

$$c'(x) - (1 - F(x))SEr = 0 \qquad (20)$$

Now suppose that we increase $r^H$ by a positive amount $\Delta$, and decrease $r^l$ by the same amount. This change preserves the mean of the rate of inspection. By the first order condition, such a change does not affect the firm's compliance effort. It also does not impact the firm's total cost of operation (which depends only on the mean rate of inspection), even though enforcement is targeted. The firm, in other words, is indifferent about changes in detection uncertainty because the cost of a possible higher inspection rate is just offset by the benefit of a possible lower inspection rate. This stands in contrast to increases in the legal and factual uncertainty, which make the firm worse off.[17]

Now consider sanction uncertainty. Under the Clean Water Act, damages can be assessed based on environmental impact of the waste discharge. That impact depends on, say, the number of fish harmed, which is uncertain. We can model sanction uncertainty in the same way as detection uncertainty. Assume that, upon enforcement, there is a high or low sanction, each arising with equal probability. The expression for the firm's payoff looks identical to the one above, with the expected sanction replacing the expected inspection rate. Thus, the same result obtains: changes in the sanction uncertainty that preserve the mean have no effect on the firm's utility in the presence of targeted enforcement.

These results have a clear policy payoff. If, for whatever reason, the government prefers greater uncertainty in a legal regime that governs plausibly risk-neutral agents such as corporations, it should not treat all uncertainty the same. Rather, it should be more reluctant to create or increase legal or factual uncertainty while being more willing to create or increase sanction or detection uncertainty. Yet in two important regulatory areas the government appears to ignore the difference between harmful and harmless types of uncertainty.

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[17] It is worth noting that we assumed that the probability of inspection is independent of the firm's compliance effort compared to the agency's view of what the law requires. This may (Raskolnikov 2016) or may not (Craswell 1998) be the case. Future research may investigate what happens when the probability of detection and the legal standard are correlated random variables.

The first such area is corporate criminal liability. Federal criminal statutes affecting corporations—such as the mail and wire fraud statute, the Foreign Corrupt Practices Act, and Racketeer Influenced and Corrupt Organizations Act—are notoriously broad and vague (Golumbic and Lichy 2014 p.1313-1314, Lynch 1997 p.36-38, Strader 2007 p.94-96). The Sentencing Guidelines for organizations (U.S. Sentencing Guidelines Manual 2015, ch. 8) base liability on such uncertain concepts as "effective" compliance programs (Baer 2009), and these Guidelines are only advisory in any event (Garrett 2014 p.518-19). Moreover, the uncertainty of the statutory law and the Guidelines pales in comparison to the almost unfettered discretion of federal prosecutors negotiating deferred prosecution and nonprosecution agreements (Baer 2009, Golumbic and Lichy 2014). These amount to a "quasi-adjudicative system administered by the" Department of Justice (Baer 2009 p.956-57). Neither the government nor the criminal law scholars appear to recognize the diverging costs of legal and sanction uncertainty to the companies operating in the United States.

The second example is tax law and tax enforcement, at least in the corporate area. It would be quite an understatement to say that the Internal Revenue Service has been reluctant to provide taxpayers with information. All informal internal interpretive advice such as Private Letter Rulings and Technical Advice Memoranda are available to the public only as a result of the decades of persistent litigation by the Tax Analysis (Tax Analysis and Advocates v. IRS 1974, Tax Notes 1998). Similarly, the enforcement statistics related to audits, civil penalties, and criminal prosecutions are public solely due to similarly long-standing and determined litigation by the founders of the Transactional Records Access Clearinghouse (Long v. IRS 1979, Tax Notes Today 2006). The agency does not appear to realize that by refusing to clarify the law it imposes a cost on even risk-neutral taxpayers, a cost that does not arise from maintaining detection uncertainty.

We show that legal and factual uncertainty are harmful even for risk-neutral agents; detection and sanction uncertainty are not. Unless the government has a particular reason to prefer harmful uncertainty to harmless one, it should reduce the former relative to the latter, other things being equal. Similarly, law reformers concerned with detrimental effects of uncertain law should focus on reducing legal (and factual) uncertainty first.

## 2.5    Cautious Preapproval

We now consider a firm that requests the agency to interpret a vague legal standard before the firm incurs the cost of complying. For example, a firm operating as a large CAFO applies for a permit and submits a waste management plan to the EPA. The regulator interprets the requirements of the Clean Water Act and either issues the permit or rejects the application. We assume that without a preapproval, the firm does not open the feedlot.

The agency enforces the law cautiously. It does not grant a permit to all operators whose plans meet the agency's interpretation of the standard. Rather, it only grants permits to those whose plans surpass the minimum compliance effort needed to meet the standard by a wide margin. This strategy is the mirror image of the targeted enforcement discussed

above. Instead of pursuing only the worst violators, the agency preapproves only the best compliers. That is, the agency engages in cautious preapproval.[18]

In terms of the timing, the firm first proposes a compliance level $x$ to the regulator. The regulator then observes the realization of an uncertain legal standard, $a$. As before, legal uncertainty is distributed according to the distribution $F(a)$, with a positive density $f(a)$. If the regulator approves the proposal, the firm reaps a benefit $b$ and incurs a cost $c(x)$. If the proposed compliance effort falls short of the realization of the legal standard, the regulator rejects the proposal.

Importantly, if the compliance exceeds the legal standard, the regulator grants a preapproval with probability $x - a$. Thus, the greater the distance between the proposed compliance effort and what the regulator thinks is necessary, the greater the probability of preapproval. Facing this problem, the firm selects a proposed compliance level to maximize

$$\left[\int_0^x (x - a)f(a)da\right][b - c(x)] \tag{21}$$

The first term is the probability of approval. The second term is the profit to the firm if its compliance proposal is approved. We have our final result.

***Proposition 3****: When the regulator grants preapproval with caution, the firm benefits from increases in legal uncertainty that preserve the mean.*

Proof

Integrate the first term by parts, yielding

$$\left[\int_0^x F(a)da\right][b - c(x)] \tag{22}$$

Denote the optimal compliance proposal by $x^*$. Denote the mean preserving spread parameter $r$, so the distribution is indexed as $F(a; r)$. Evaluated at the optimal proposal, the firm profit is

$$\left[\int_0^{x^*} F(a; r)da\right][b - c(x^*)] \tag{23}$$

The derivative of this expression with respect to $r$ is

$$\left[\int_0^{x^*} F_r(a; r)da\right][b - c(x^*)] \tag{24}$$

This expression is positive by the definition of the mean preserving spread∎

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[18] It is difficult to prove that when the IRS considers private letter ruling requests, or when the SEC takes up no-action letter requests, the agency refuses to bless transactions that it considers to be legal but close to the line. But we find this behavior highly intuitive, and our private conversations with former government officials suggest that the description offered here is by no means far-fetched.

The agency only approves the firm's proposed compliance effort if the agency is sure that the effort satisfies the legal standard. What makes the agency sure is a large distance between the compliance effort suggested by the firm and what the agency deems necessary to assure legality of the action. An increase in a mean preserving spread of the distribution means that the agency is more likely to think that the necessary compliance effort is very high and also that the necessary compliance effort is very low. The firm cannot predict which of these alternatives will come to pass. However, it does not matter to the firm whether the agency believes that a high compliance effort is required or an extremely high one. Either way, the agency is apt to reject the firm's proposal. Matters differ, however, when the agency thinks that the necessary compliance effort is not just low, but very low. In that case, the agency is more likely to preapprove the transaction. This, of course, would allow the firm to capture benefit.

In short, the firm is better off from greater uncertainty because an increased chance that the agency will demand a very high compliance effort yields no extra cost for the firm while an increased chance that the agency will require a very low compliance effort does benefit for the firm.

**CONCLUSION**

Uncertainty is pervasive and persistent in any legal system. It comes in many flavors, and it frequently reflects lawmaker's choices, whether deliberate or not. Legal uncertainty depends on how legislators and courts choose to formulate legal commands. Factual uncertainty can be increased or reduced by the choice of legally relevant facts. Detection uncertainty is a product of enforcement choices. And while sanction uncertainty may be difficult to manage in some cases (such as accidental and environmental harms), lawmakers may readily decrease it in many settings (such as by narrowing the ranges in the U.S. Sentencing Guidelines and making the Guidelines mandatory).

Given all these design choices, lawmakers should be interested in the effects that various types of uncertainty have on the wellbeing of the regulated subjects. Our key finding is that greater legal and factual uncertainty harm risk-neutral subjects if enforcement is targeted. Given that legal and factual uncertainty are all but inevitable in any legal system, and that targeted enforcement is widespread, the harmful effects that we identify are likely to have real practical significance in a wide range legal contexts.

More generally, our analysis highlights the need for a fairly fine-grained investigation of real-life regulatory regimes. Uncertainty in a legal system may be harmful, harmless, or beneficial even for risk-neutral agents depending on the type of uncertainty, the structure of sanctions, and the specifics of enforcement. While legal and factual uncertainty are harmful, detection and sanctions uncertainty are not. Legal and factual uncertainty make risk-neutral agents worse off if enforcement is targeted (or if sanctions are graduated) but not otherwise. A cautious preapproval setting reverses the effect of legal uncertainty, making it beneficial.

All these findings are new to the literature, which has mostly relied  on a stylized depiction of the regulatory environment. Various types of law-related uncertainty are

often represented by a single variable in economic models. While appropriate for some purposes, this simplification obscures the difference between harmful and harmless uncertainty in law. This difference is not just of theoretical interest. Rather, it informs important government policies like the deterrence of corporate crime and the collection of corporate tax. Thus, the most general lesson from our study is that the modern law-and-economics analysis is likely to benefit from identifying and investigating the essential, realistic, and relatively nuanced features of the legal system.

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