Abstract: Hoeppner and Lyhs (2015) have investigated the presence of
defensive behaviour and negligence when legal standards are uncertain, based
on a theoretical model by Calfee and Craswell (1986). In the current paper
I expand the model to include theories of social preferences, to test the
robustness of Hoeppner and Lyhs (2015)’s results and take a closer look at
the specific effect of legal standard vagueness in principal-agent relationships
and whether pro-social preferences can mitigate the occurrence of defensive
behaviour.

I replicate the presence of overcompliance, without the characteristic U-
shaped relationship between precaution and the level of standard vagueness.
Furthermore, I do not find a difference in behaviour when a second player
is affected by the level of precaution. Results cast doubt on the theoretical
predictions of Calfee and Craswell (1986) as well as on the experimental results
of Hoeppner and Lyhs (2015) and consistently point to defensive behavior, as
a consequence of standard vagueness. I also show that internalized pro-social
preferences influence decision making at relatively low levels of standard
vagueness, but loose their coordinating potential when standards become
sufficiently vague.

“Much of the uncertainty of law is not an unfortunate accident:
it is of immense social value.”
— Sonia Sotomayor (1996),
Returning Majesty To The Law and Politics: A Modern
Approach, p. v

* Friedrich Schiller University, Jena, Germany (Laura.Lyhs@uni-jena.de). I am grateful for feedback
and valuable advice by Christoph Engel, Sven Hoeppner and Oliver Kirchkamp.
1 Introduction

The discomfort of legal scholars with the prevalence of legal indeterminacy and legal uncertainty has been frequently discussed in legal philosophy over the last two centuries. In 1823, Jeremy Bentham expressed his dislike for the unpredictability of the common law, which he largely associated with the fact that law was created ex-post, rather than provided to society ex-ante (Bentham, 1823, ch. XVII, sec. 83). Bentham also viewed this feature of uncodified law as a major forgone opportunity for the lawmaker: in sanctioning ex post, the lawmaker cannot use the law to provide a behavioural framework to steer society as a whole.\(^1\) The realisation that codification also fails to eradicate uncertainty is discussed just as comprehensively by scholars of civil law. The most passionate illustration is provided by Von Jhering, referring to his dream of the heaven for legal theoreticians. In this dream he envisioned finally seeing the entirety of vague concepts of jurisprudence present themselves in perfect clarity (Von Jhering, 1884).

Codification cannot dispose of that share of legal uncertainty that originates from the use of imprecise legal concepts, such as due, reasonable, contract, conspiracy, malice or proximate cause, which can all be manipulated in a variety of acceptable ways (Cohen, 1935). Indeterminacy of codified law prevails because the complete clarification of vague concepts would require their meticulous definition for each possible situation. The cost of generating and handling such a comprehensive code would be prohibitive. Furthermore, greater specificity of a code is also associated with a high likelihood for internal inconsistencies (D’Amato, 1983). Given that uncertainty prevails, irrespective of the underlying legal system, its effect on behaviour and the extent to which it can be guided should be investigated.

The effect of probabilistic enforcement on compliance with the law was initially formalised by Becker (1968) in the context of the deterrence of criminal behaviour. According to his deterrence hypothesis, crime rates decline in increases in the probability of punishment, as the expected cost to some criminals of punishment outweighs the expected benefit of the criminal activity.\(^2\)

Outside of criminal law, legal standard vagueness brings about a similar trade-off as probabilistic criminal enforcement (Sunstein, 1995): The probability of being held liable at a given level of undercompliance decreases in increases of legal standard vagueness. Hence, increases in standard vagueness reduce the expected cost of liability at any level of undercompliance, and make undercompliance relatively more attractive to the agent. As compared to the criminal scenario, there exists a further dimension in which the agent’s behaviour can diverge from the optimum under a vague legal standard, namely by making overcompliant or defensive choices. Even at high levels of precaution, agents face a positive probability of being held liable, which they can reduce by increasing their

\(^1\) Bentham goes so far as to compare the development of the common law to the way a dog is taught to behave: "When your dog does anything you want to break him of, you wait till he does it, and then beat him for it. This is the way you make laws for your dog and this is the way judges made law for you and me." (Works V 235)

\(^2\) The deterrence hypothesis states that criminal behaviour declines both in the probability of punishment, as well as in the magnitude of the fine.
compliance efforts even further. As a result, legal standard vagueness might actually stifle behaviour that the law-maker seeks to encourage (D’Amato, 1983).

The contributions of Calfee and Craswell (1984) and Craswell and Calfee (1986) formalise these two opposing effects of legal standard uncertainty on actors’ efforts to comply with the law. In a pure expected-value framework, Craswell and Calfee (1986) conclude that relatively low levels of uncertainty cause actors to overcomply with the standard, while relatively high levels of standard vagueness will induce undercompliance.

Hoeppner and Lyhs (2015) (HL, hereafter) expand the model of Craswell and Calfee (1986) to incorporate various behavioural paradigms, and they use a laboratory experiment to test the predictions. The results confirm the predictions from the original paper, reject the influence of prospect theory, point out the importance of individual risk preferences, and suggest that both overcompliance and undercompliance can be consequences of legal uncertainty. Furthermore, the findings suggest that increasing legal standard vagueness might actually decrease the deviation from the lawmaker’s desired behaviour, and therefore increase social efficiency. There is even evidence that, at least in theory, there exists a level of standard vagueness that induces compliance and which can therefore serve as a second-best alternative to legal certainty. This notion of positive effects from legal uncertainty is also in line with the theoretical findings of Lang (2014) and a more general reconsideration of the issue outside of traditional legal scholarship.

This paper complements HL by allowing for the presence of social preferences in the actor’s utility function. This is relevant from a theoretical point of view, as it reverses the original model’s predictions in terms of over- and undercompliance. With regard to the application of the results, social preferences likely play a role in all circumstances in which decision making agents are aware of the externality they might produce, and particularly when they can also identify the party who bears the cost. Principal-agent relationships, such as the physician-patient relationship can serve as practical examples, where the defensive behaviour is particularly frequent.

The scope of defensive behaviour in the medical sector is illustrated by Studdert et al. (2005). The authors find that 93% of the responding physicians admit to the practise of defensive medicine, indicating that they deviate from optimal behaviour to reduce their chance of liability. Thirty-nine percent of the specialist physicians have decided to restrict treatments in cases of high liability risk, a practise that is known as ‘negative defensive medicine’. Fifty-nine percent of the surveyed physicians admitted to being overcautious, or engaging in so-called ‘positive defensive medicine’. This proportion was significantly higher amongst specialist practitioners. A more recent study by Bishop, Federman, and Keyhani (2010) confirms this finding. The authors determine that 91% of physicians in the US believe that malpractice pressure leads to an increase in the number of ordered diagnostic tests and procedures beyond the necessary amount. Hence, insight into the effect of vague standards holds the potential for vast savings from overprecaution.

In the paper I focus on three main behavioural theories that would explain a divergence from HL. All three are used to explain distributional choices in one-shot games.

A first theory explains individuals’ choices by their preference for equitable outcomes, following the formalisation of Fehr and Schmidt (1999). Inequity aversion claims that
individuals experience disutility from either receiving a higher payoff or a lower payoff than their peers. Secondly, I will incorporate a preference for social efficiency into the model. Experimental evidence shows that subjects in binary-choice dictator games were more willing to make efficiency promoting choices than equity oriented ones, even if this reduced the individual’s own payoff (Bolle and Kritikos, 2001). Furthermore, Andreoni and Miller (2002), Charness and Rabin (2002) and Engelmann and Strobel (2004) show that the giving behaviour of a non-negligible fraction of participants, in a range of games, can be explained with a preference for socially efficient outcome. As a third theory I will consider that decision making agents attach weight to the outcome of the least well-off individual in a given society. These Rawlsian or maximin preferences have contributed to the explanation of the results of several laboratory experiments (Andreoni and Miller, 2002; Charness and Rabin, 2002; Engelmann and Strobel, 2004).

In the following Section 2, I will derive the basic theoretical model which is based on the work of Craswell and Calfee (1986). Subsequently, I will incorporate the behavioural theories mentioned above, and derive hypotheses for the behaviour of the decision making agent. I will then describe the methods for testing the validity of the predictions in Section 3. I will provide the experimental results in Section 4, and discuss their implications in Section 5. In Section 6, I offer concluding remarks.

2 Theory & Predictions

Similarly to HL, I derive predictions from a model that is based on Craswell and Calfee (1986). In the model, a rational and self-interested agent chooses the intensity with which she carries out a particular activity \( x \) with \( x \in [0, \bar{x}] \), where \( \bar{x} \) represents the upper boundary of the activity level \( x \). The agent profits from engaging in activity \( x \) according to the benefit function \( b(x) \), which is assumed to be concave, i.e. \( b'(x) > 0, b''(x) \leq 0 \).

Engaging in activity \( x \) also generates a negative externality \( e(x) \), which presents a cost to another person. Examples of such externality producing activities are pollution generating production processes and the speed with which a person operates a vehicle, which increases the expected damage from accidents. I assume that the externality function \( e(x) \) is twice differentiable and convex, i.e., \( e'(x) > 0, e''(x) \geq 0 \).

The socially optimal level, \( x_s \), maximises the difference between the benefit from activity \( x \) and the cost from the externality. Hence, optimality is achieved when the condition \( b'(x) = e'(x) \) is met, when the marginal benefit from activity \( x \) yields the marginal cost. From a social perspective neither overcompliance, choices where \( x > x_s \), nor undercompliance, where \( x < x_s \), is desirable, as both entail a deviation from the social optimum and are associated with welfare losses.

In the model a legal standard \( X_l \), with \( X_l < \bar{x} \), is imposed to regulate activity \( x \). The legal standard represents the maximum quantity of activity \( x \) that is tolerated in the particular society, and can be thought of as a quantity restriction on pollution or as a speed limit. As long as the agent chooses an activity level below or equal to this legal standard, \( x \leq X_l < \bar{x} \), she is considered compliant and will not face legal consequences. Inversely, an agent who chooses \( X_l < x \leq \bar{x} \), violates the legal standard and has to
perfectly compensate the other person for the costs of the externality.

In order to introduce legal uncertainty into the model, I assume that the legal standard is not fixed, but rather that it is normally distributed around the optimal level, \( x_s \), i.e., \( X_l \sim \mathcal{N}(x_s, \sigma) \).\(^3\) When the agent selects her activity level, she only knows that with increasing \( x \), there is an increasing probability \( P(x > X_l) = \Phi(x) \) with \( \phi(x) > 0 \) that she will be found in violation with \( X_l \) and will therefore be held liable. Conversely, \( P(x \leq X_l) = 1 - \Phi(x) \) represents the (counter-)probability that the agent is found compliant with \( X_l \).

The assumption of the stochastic nature of \( X_l \) is intended to reflect real world scenarios, such as the differing interpretation of vague legal standards, the ex-post determination of standards of care or generally imperfect knowledge about the law by those who are subject to it.

The degree of standard vagueness is given by the standard deviation \( \sigma \) of \( F(x) \). A larger \( \sigma \) indicates a wider range of possible legal standards, \( X_l \), around the distribution mean, \( x_s \).

### 2.1 Standard preferences & risk neutrality

In this section I present the original preference structure according to the model by Craswell and Calfee (1986), in which a risk-neutral (RN) agent derives utility from her choice of \( x \) according to the utility function:

\[
U_{RN}(x) = \begin{cases} 
  b(x) & \text{if } x \leq X_l \text{ (compliance)} \\
  b(x) - e(x) & \text{if } x > X_l \text{ (violation)} 
\end{cases}.
\]

For any choice of \( x \), his expected utility is

\[
U_{RN}(x) = b(x) - \Phi(x) e(x). \quad (2)
\]

I differentiate \( U_{RN}(x) \) with respect to \( x \) and evaluate the expression at the social optimum, \( x_s \), where \( b'(x) = e'(x) \):

\[
\left. \frac{\partial U_{RN}(x)}{\partial x} \right|_{x_s} = (1 - \Phi(x_s)) e'(x_s) - \phi(x_s) e(x_s). \quad (3)
\]

The first term of Expression (3) encompasses the gain from decreasing the size of the liability payment by reducing \( x \). This gain is discounted by the probability of complying with the legal standard. The second term of Expression (3) presents the offsetting effect identified by Craswell and Calfee (1986). If Expression (3) becomes negative, there exists an incentive for overcompliance. Inversely, agents have an incentive to undercomply when the expression is positive.

\(^3\) As a robustness check, HL depicted predictions for the case where \( X_l \) is uniformly distributed in the Appendix A to their paper.
As in HL the risk neutral agent’s optimal choice $x^*_{RN}$ is a function of the level of standard vagueness, $x^*_{RN} = x^*_{RN}(\sigma)$.

**Figure 1** Over- and undercompliance for different preference structures

Figure 1 on page 6 depicts this relation. The vertical axis of the graph in Figure 1 measures the activity level and depicts the individually optimal choice $x^*$ relative to the socially optimal level $x_s$. The horizontal axis in the graph measures the standard deviation, $\sigma$, of the distribution of the legal standard. The solid line in Figure 1 represents the response function $x^*_{RN}(\sigma)$. The latter, $x^*_{RN}(\sigma)$, resembles the predictions by Craswell and Calfee (1986): if $\mu = x_s = X_l$, a sufficiently low level of standard vagueness is associated with overcompliance until a tipping point is reached. Beyond this tipping point, any further increases in $\sigma$ lead to a reduction of overcompliance and, eventually to undercompliance. The shape of the response function allows two main conclusions.

---

4 The numerical approximations of all relations $x^*_i(\sigma)$ with $i \in \{RN, IE, SE\}$ in Figure 1 have been constructed with the software environment R. A mathematical solution was not possible because $F(x)$ has no closed form representation.
First, reductions in the standard vagueness do not always lead to more efficient choices. Depending on the initial level of uncertainty, vagueness reductions can actually increase the deviation from the optimum (i.e., the difference between $x^*$ and $x_s = X_l$ may increase $x_s$).\footnote{Please refer to Craswell and Calfee (1986) for a more extensive analysis within the risk neutral framework. The authors also point out that reductions in uncertainty can lead to both: increases in over- and undercompliance.} Secondly, it must be pointed out that there exists at least one further level of standard vagueness, aside from legal certainty, at which the risk neutral agent decides for the socially optimal activity level $x^*_{RN}(\sigma) = x^*_{RN}(0) = x_s$.

HL have tested this scenario in the lab and have collected evidence that confirms the behaviour predicted for risk neutral agents with standard preferences by Craswell and Calfee (1986). While the original paper and the model extension by HL assume the presence of an affected party, neither paper takes payoff distribution preferences or cumulative payoff preferences into account. I therefore develop alternative predictions for the chosen activity levels, which are based on different models of social preferences.

### 2.2 Social Preferences: Inequity Aversion

The distinctive difference between this paper and the experimental paper by HL is that the chosen activity level creates an actual negative externality, forcing the decision making agent to trade off the size of her own payoff against the size of another participant’s payoff. The particular decision situation can be compared with two well-researched situations.

On the one hand, this scenario resembles the dictator game (Kahneman, Knetsch, and Thaler, 1986): In the dictator game, one party (the dictator) determines how to divide a sum of money between herself and another person (the recipient). The choice of the activity level is analogous in that the decision maker’s own profits and the ‘recipient’s’ damages increase in the activity level, inducing the ‘dictator’ to make a trade-off between the division of payoffs and the size of the pie by choosing an activity level.

The scenario also shares a crucial trait with the ultimatum game (Güth, Schmittberger, and Schwarze, 1982): In the ultimatum game, one party divides a sum of money between herself and a recipient. The recipient can then decide to accept or reject the offer of division. If the recipient rejects the offer, neither party receives any payoff. Dictators in the ultimatum game and the active party who chooses an activity level both face a vague behavioural standard. The dictators in the ultimatum game don’t know whether a given ‘offer’ will be accepted by the recipient, and the decision maker in the HL decision situation does not know with certainty whether the chosen activity level meets the vague standard. Yet, in both cases the decision makers know that they can influence the probability of not meeting the standard by changing the generosity of their offer.

Experimental evidence shows that decision makers do not merely maximise their own payoffs in either situation. Instead fairness and efficiency concerns play a role. For the sake of making more accurate predictions, I will include these type of preferences into the decision making agent’s utility function.

In the first reconsideration of the model I incorporate inequity aversion. Hence, I assume that the decision making agent is averse to payoff inequality that may result from
her chosen level of activity $x$. On the one hand, the agent may experience disutility when she is relatively better off than the person who bears the cost of the externality from activity $x$ (compassion). On the other hand, she may also experience disutility when a liability payment leaves her worse off than the harmed individual (envy).

Inequity aversion enters the model according to the description of Fehr and Schmidt (1999). A decision making agent experiences disutility both when another individual receives payoffs above an upper equitable benchmark and when that other individual receives payoffs below a lower equitable benchmark. There are multiple options for the selected equitable benchmark with which she compares the other’s payoff. In line with Fehr and Schmidt (1999), I assume that a person will use her own final payoff as the relevant equitable benchmark to which she compares another person’s payoff.\(^6\)

Therefore, let an inequity averse person derive utility as described by the following utility function:

$$U_{IE}(m_i, m_j) = m_i - \alpha \max[m_j - m_i, 0] - \beta \max[m_i - m_j, 0]$$

where $m_i$ describes the inequity averse agent’s payoff, $m_j$ describes the other’s payoff, $\max[m_j - m_i, 0]$ reflects the disutility from envy that is weighted by parameter $\alpha$, and $\max[m_i - m_j, 0]$ represents disutility from compassion that is weighted by parameter $\beta$. In line with Fehr and Schmidt (1999) I assume $\alpha \geq \beta$ and $0 \leq \beta < 1$. The first condition implies that a decision making agent has a larger disutility from receiving a dollar less than the other person, than from receiving a dollar more. The second condition implies that the agent experiences disutility from being better off than the other person, but not enough to dispose of her own payoff.

In case a person is found compliant with $X_l$, her payoff is $m_i = b(x)$ and the other’s payoff is $m_j = -e(x)$. Conversely, if a person is found to violate $X_l$, her payoff is $m_i = b(x) - e(x)$ due to payment of damages and the others payoff is $m_j = -e(x) + e(x) = 0$ due to perfect compensation. Therefore, I can specify an inequity averse person’s utility who decides on $x$ as follows:

---

\(^6\) Note, that this is just one option. A person may alternatively care about, e.g., deviations from the status-quo or from the group’s mean payoff.
An inequity averse agent who seeks to maximise expected utility therefore solves:

$$\max_x E[U_{IE}(b(x), e(x))]$$

$$\leftarrow (1 - \Phi(x)) [b(x) - \beta [b(x) + e(x)]] + \Phi(x) [b(x) - e(x) - E(x) - C(x)]$$  \hspace{1cm} (6)$$

Differentiating $E[U_{IE}(b(x), e(x))]$ with respect to $x$ and evaluating this result at the social optimum $x_{so}$ where $b'(x) = e'(x)$, we obtain:

$$\frac{\partial U_{IE}(b(x), e(x))}{\partial x} = (1 - \Phi(x_{IE}^*)) (1 - 2\beta) b'(x_{IE}^*) - \phi(x_{IE}^*) (e(x_{IE}^*)$$

$$- \beta [b(x_{IE}^*) + e(x_{IE}^*)] + E(x_{IE}^*) + C(x_{IE}^*)] \doteq 0$$  \hspace{1cm} (7)$$

The dotted line in Figure 1 represents a numerical approximation of $x_{IE}^*(\sigma)$. I employ parameter values of $\alpha \approx 0.611$ and $\beta \approx 0.525$, which are the median values, found in a set of experiments by Blanco, Engelmann, and Normann (2011). For the chosen parameters, $x_{IE}^*(\sigma)$ generates prediction which oppose $x_{RN}^*(\sigma)$: a sufficiently low level of $\sigma$ induces undercompliance, while further increases of vagueness first reduce undercompliance and eventually induce overcompliance. However, the deviation from the social optimum is
always smaller, as compared to the standard case. It can be noted that the standard choice pattern under risk neutrality can also be produced within this model, as long as the decision maker is indifferent to the other person’s payoff being less than his own, $\beta \leq 0$.

2.3 Preferences for social efficiency

If I relax the imposed parameter restrictions with regard to $\alpha$ and $\beta$, we can think of a setting in which the envy parameter $\alpha$ becomes negative. This signifies that the agent derives positive utility from the surplus payoff that another person has compared to the agent. If the compassion parameter $\beta$ remains positive as well, the decision making agent’s preferences become concerned with the overall payoff in society, or efficiency. While inequity aversion is frequently discussed as the behavioural motivation to explain non-selfish behaviour in a variety of games, multiple experiments have shown that the model actually lacks explanatory power. Engelmann and Strobel (2004) test the relative performance of efficiency concerns, maximin preferences and inequality aversion against each other. The data points to a stronger influence of social efficiency and maximin concerns as compared to that of inequality aversion. In line with this finding, Andreoni and Miller (2002) estimate that about 22.4% of their sample exhibited some degree of preference for social efficiency and Bolle and Kritikos (2001) find a majority of efficiency-oriented participants in binary dictator games.

If individuals are perfectly efficiency minded, they prefer the maximisation of net social benefits and are indifferent which party bears the costs of the externality. For parameter values of $\alpha = -0.5$ and $\beta = 0.5$, the agent’s preferences coincide with the the goal of the sophisticated lawmaker in the scenario at hand and the agent chooses an activity level of $x_{SE}(\sigma) = x_s = X_l$ which is depicted as the dashed line in Figure 1.

However, it is more common that individuals have somewhat weaker concerns for social efficiency. In these cases, the presence of efficiency concerns in the utility function will decrease, but not eliminate, the degree of overcompliance or undercompliance in the scenario.

Indifference to the liability payment is specific to the specified scenario in which litigation is costless and punitive damages are excluded. Introducing litigation costs or punitive damages would reduce the chosen activity level, $x_{SE}^*(\sigma)$, at every level of legal standard vagueness.

2.4 Social Preferences: maximising the minimum payoff

While inequity aversion has a certain explanatory power for the behaviour in ultimatum games and public goods games, it does not do as well in predicting allocations in dictator games (Andreoni and Miller, 2002).

As mentioned in the previous section, Andreoni and Miller (2002) find that behaviour differs according to types. Aside from the group that made decisions with social efficiency in mind, a further 47.2% of the sample behaved in a selfish manner. The remaining 30.4% preferred equal payoffs for the participants, implying maximin preferences.
We derive behavioral predictions, based on Rawls’ maximin principle, by changing the assumptions over $\alpha$ and $\beta$ in Equation (5). If $\alpha = 0$ and $\beta = 1$, a person derives positive utility from his own payoff but is indifferent to another person faring better than her. On the other hand, the person receives a unit-for-unit reduction in her utility, from the difference between her own payoff and that of another person who receives less. Changing the envy and compassion parameters in this way simplifies the utility function to the following:

$$U_{MM}(m_i, m_j) = \min[E(m_i), E(m_j)]$$

(8)

Which can be specified as:

$$U_{MM}(b(x), e(x)) = \begin{cases} 
\min[b(x), -e(x)] & \text{if } x \leq X_l \\
\min[b(x) - e(x), 0] & \text{if } x > X_l 
\end{cases}$$

(compliance)

(9)

$$= \begin{cases} 
-e(x) & \text{if } x \leq X_l \\
0 & \text{if } x > X_l \\
0 & \text{if } x > X_l \\
0 & \text{if } x \leq X_l \\
b(x) - e(x) & \text{if } x > X_l \\
& b(x) \geq e(x) \\
& b(x) < e(x)
\end{cases}$$

(10)

Therefore the agent maximises the following function:

$$\max_x E[U_{MM}(b(x), e(x))]$$

$$\iff (1 - \Phi(x)) \min[b(x), -e(x)] + \Phi(x) \min[b(x) - e(x), 0]$$

(11)

In the case at hand, the person who bears the cost of the externality is worse-off. There exist two ways in which the agent can maximise her payoff: either by choosing not to engage in the activity at all, $x^*_{MM}(\sigma) = 0$, or by increasing the activity level to the point at which liability is certain, $\Phi(x) = 1$. The maximin-seeking agent will do the latter, as long as the benefit from the undertaking the activity at this level, $x^*_{MM}(\sigma)$, is still larger than the cost from the liability payment, $b(x_{\Phi=1}) \geq e(x_{\Phi=1})$. If this is no longer
the case, the agent will choose not to engage in the activity at all. Activity choices under these types of preferences are depicted in Figure 5 in Appendix 8.

3 Experimental design

I conducted a computer-based experiment to measure how compliance changes when the degree of legal standard vagueness is varied and when a negative externality is imposed on a second participant. Participants were asked to make a compliance choice under each of 6 different degrees of standard vagueness, both in conditions without negative externality and with negative externality. The six choices in which no externality is imposed on another player are equivalent to HL and were intended to serve as a robustness check for the previous results, as well as a base of comparison for the externality-generating case. I will hereafter refer to these first six choices as the baseline results. In order to easily distinguish between the results from the two sets of choices, I will refer to the results from the externality-generating case as treatment results. In each of the 12 conditions, participants used a slider to choose an activity level between 0 and 1000 units. If their chosen activity level was at or below the subsequently determined maximum level, the participant earned a full payoff. If the chosen activity level was higher than the maximum level, the participant had to repay part of the payoff, either to the experimenter or to a second player who had been affected by the negative externality from the activity. The degree of vagueness in the legal standard determined the probability of a repayment at every chosen activity level. Choosing an activity level therefore resembled a choice between 1001 lotteries with different payoffs and probabilities.

The experiment was programmed using z-Tree (Fischbacher, 2007). I conducted 5 sessions with a total of 78 participants in December 2015 at the economic laboratory of the Friedrich Schiller University in Jena. Two participants had to be excluded, leaving a total of 76 observations. The participants were students recruited through Orsee (Greiner, 2004). All decisions were incentivised, with average earnings amounting to about €9, including the mandatory show-up fee of €2,50. Each session lasted approximately 45 minutes. The participants received instructions via video clips to explain the functionality of the computer interface, illustrate earning opportunities and most importantly to provide an effective visual aid in explaining the construction and consequence of the vague behavioural standard.

3.1 Task

In the first stage of the main game the participants were asked to select their preferred activity level by using a slider. The higher the chosen activity level, the higher was the potential payoff in each of the 12 conditions. The interface provided graphical representations of the potential payoff, the potential payback and the likelihood of meeting the behavioural standard. Payoffs were reported in Experimental Currency Units (ECU), where 1 ECU was equal to €0.04. Specifically, payoffs for the slider choice were:
\( \Pi(x) = \begin{cases} b(x) = 50 \ln(x) & \text{if } x \leq X_l \text{ (compliance)} \\ b(x) - e(x) = 50 \ln(x) - 0.1x & \text{if } x > X_l \text{ (violation)} \end{cases} \)

In the second stage of the main game the liability standard \( X_l \) was drawn from a normal distribution, with a mean of 500 and a standard deviation which reflected the relevant degree of legal uncertainty. The six different levels of standard vagueness were represented by standard deviations of \( \sigma_i \in \{1, 100, 200, 300, 400, 500\} \).

It was then determined whether the chosen activity level was compliant with the drawn liability standard \( X_l \). If the activity level was smaller or equal to the liability standard, the participant received the full payoff \( b(x) \). If the activity level exceeded the standard, the participant received \( b(x) \) less the repayment \( e(x) \). The structure of the main game is illustrated in Figure 2.

**Figure 2** Game representation of the main task

Stage 1:
Choice of activity level \( x \)

Stage 2:
Standard \( X_l \) is determined

\( x \leq X_l \quad x > X_l \)

Outcomes for decision maker:
\( 150 \text{ECU} + b(x) \quad 150 \text{ECU} + b(x) - e(x) \)

Outcomes for passive participant:
\( 150 \text{ECU} - e(x) \quad 150 \text{ECU} \)

Only relevant for decisions 7-12.

To collect information on chosen activity levels under various degrees of legal uncertainty and also in the presence and absence of a second player, each participant took 12 decisions: each was asked to pick an activity level under 6 different levels of standard vagueness, both with and without an affected second player.\(^7\) All twelve decisions were made in

\(^7\) The six specific choice situations are derived from Craswell and Calfee (1986)'s Table 1, using the
one stage and within the same screen. The computer screen featured icons for all 12
decisions and participants could choose the order in which they attended to the scenarios
by clicking on the icons. They could also edit previous decisions. This set-up was chosen
to prevent effects related to the sequence in which the scenarios were presented, and to
allow participants to compare scenarios and previous decisions. See Appendix 9 for a
sample decision screen from the experiment (Figure 6).

For the six decision scenarios in which another player was affected, all participants
were separated into 'active' and 'passive' participants. Active participants selected an
activity level which imposed a negative externality on a passive player. The participants
were not informed about their role and they decided for an activity level as if they were
an active type. All participants received an initial endowment of 150 ECU before the
first stage to prevent a negative payoff for passive types.

After the main task, I conducted two post-tests to reveal participants’ social- and risk
preferences. I elicited risk preferences following a multiple price list approach according
to Holt and Laury (2002) and elicited social preferences according to the ring measure as
devised by Murphy, Ackermann, and Handgraaf (2011) and implemented for z-Tree by
Crosetto, Weisel, and Winter (2012).

3.2 Experimental hypotheses

Before analysing the effect of adding a real second player, I establish whether my baseline
data replicates HL. Therefore, I am interested in the shape of average chosen activity
levels in the baseline section of the experiment. As in HL, I want to determine whether
the data follows a U-shape, with decreasing activity levels up to a turning point, after
which activity levels increase as predicted by Craswell and Calfee (1986). Therefore my
Hypothesis 1 comprises the three main hypotheses of HL:

**Hypothesis 1 (U-shape):** The baseline condition behaviour follows a U-shape,
exhibiting reductions in the activity level at low levels of standard vagueness and
increases in activity levels at high levels of standard vagueness.

After establishing the baseline case, Hypothesis 2 is concerned with the presence of a
treatment effect. Specifically, I determine whether the chosen activity levels from the
baseline section lie below the activity level from the treatment section of the experiment,
as predicted in Section 2.

**Hypothesis 2 (treatment effect):** At all tested levels of standard deviation, activity
levels in the baseline condition lie below the chosen activity levels in the treatment
condition.

Hypothesis 3 is concerned with the degree of divergence between baseline and treatment
section. The vast majority of the models in Section 2 predict not only higher average
same parameterisation as in HL.
activity levels in the treatment section, but also that they will be well above the socially efficient level.

**Hypothesis 3 (undercompliance):** At all tested levels of standard deviation in the treatment condition, participants will choose an activity level in the undercompliance domain.

In Hypothesis 4 I focus on the effect of social value orientation (SVO) on the shape of the response function. Social value orientation is measured in an incentivized post test, in terms of a continuous measure, allowing to compare participants in terms of their relative preference for individualistic, prosocial or altruistic decisions. In line with the predictions in Section 2, I hypothesize that these measures affect the overall level of choice behavior and affect the shape of the response function, with higher values of the inequality aversion score/angle leading to decreased concavity in the response function in the treatment section of the data.

**Hypothesis 4 (social value orientation):** Social value orientation affects activity choice, both in terms of the level of behavior and in terms of the shape of the response function. The linear effect is (more) positive, while the shape is ’more concave’.

In Hypothesis 5 I will shed light on the development of the variability of decisions. In HL, we referred to the increasing variability of chosen activity levels at higher levels of legal standard vagueness as ’erratic behaviour’. This pattern embodies a considerable social cost of standard vagueness, namely the loss in coordination, brought about by (relatively) certain legal standards. I want to test whether the degree of this costly loss of coordination persists in the treatment section.

**Hypothesis 5 (variability):** The variability of chosen activity levels increases with the level of standard vagueness in baseline and treatment group.

### 4 Analysis & Results

I present the results in two subsections. Initially I provide descriptive statistics and highlight the differences and similarities to HL. Secondly, I will evaluate in detail the experimental hypotheses set out in Subsection 3.2.

#### 4.1 Descriptive statistics and relation to the previous experiment

The sample consists of 76 students from various academic backgrounds. The average age was about 25 years, and approximately 57% of the sample were female.

---

8 The original data set includes 78 participants. One participant with prior knowledge of the main game and one participant who failed to answer the comprehension questions were eliminated from the data set, prior to the analysis.
In order to get a better impression of the level of comprehension in the main game, all participants were asked to report on their knowledge of mathematics and their perceived understanding of the main task within an unincentivised questionnaire at the end of the experiment. Roughly 79% of the participants reported being comfortable with handling fractions and calculating percentages, which is crucial to completing the choice task. Despite the presence of participants with relatively low self-reported math skills, about 96% of the participants stated that they fully understood the task. The results are summarised in Table 3 in Appendix 10.

Figure 3 depicts the average activity choices from the main game and compares the data to the results of HL. The left panel shows the mean activity level, for each level of standard vagueness. The green line shows the U-shaped response curve, as found by HL. The equivalent data from the baseline section of the recent study is depicted by the grey line, and decisions with an externality-affected second party are depicted by the black line.

Neither the data from the baseline section, nor the data from the treatment section seem to replicate the findings of HL, as per Hypothesis 1. Furthermore, activity levels in the treatment section do not appear to be significantly higher than in the baseline section (Hypothesis 2) and average activity levels in both data sections lie in the overcompliance domain (Hypothesis 3).

The right panel of Figure 3 displays the standard deviation of the choices at each activity level, which is used to measure the degree of volatility and unpredictability in behaviour. The data seems to reinforce HL’s finding that behaviour becomes more erratic as the legal standard vagueness increases (Hypothesis 5).

**Figure 3** Mean and standard deviation of activity choices at each vagueness level

![Figure 3](image-url)
4.2 Testing the hypotheses

4.2.1 Hypothesis I: U-shape in the baseline results

In Hypothesis 1 (U-shape), I suppose that average activity levels in the baseline section of the experiment initially decrease with standard vagueness and after a turning point commence to increase. This forms the characteristic U-shape, detected earlier in HL. While Figure 3 in the previous section does not display a U-shape for the baseline data, I proceed to formally test this intuition in two parts: First, I test for the existence of a decreasing trend in the chosen activity levels as standard vagueness increases. Then I test for an increasing trend. In the initial Jonckheere-Terpstra test, I test for ordered differences among activity choices at different levels of standard deviation. The results are displayed in Table 4 in Appendix 11. I reject the null hypothesis of equal medians, in favor of the one-sided alternative, stating a monotonic decrease in activity level, which is in line with the observation from Figure 3, but does not provide support for Hypothesis 1.

Subsequently, I estimate the chosen activity level in the baseline section of the data as a function of standard vagueness (SD) and squared standard vagueness, in order to check for convexity. The coefficient of squared standard vagueness in Table 1 is positive and significant, pointing to a very slight convexity. Yet, the coefficient of the standard vagueness is negative, pointing to an overall negative trend. It is worth noticing that risk preferences have a significant effect on choice behavior. The higher the degree of risk aversion, the lower the selected activity level. While I find convexity, the observed negative overall trend points to defensive behavior without a return to the efficient activity level at higher levels of standard vagueness. Hence, I do not find evidence in support of Hypothesis 1 and cannot conclude that activity choices follow a U-shaped pattern in the baseline part of the experiment.

A more detailed analysis of the heterogeneity of the individual response patterns is conducted by estimating the individual coefficients for standard vagueness and squared standard vagueness, and plotting these against each other in Figure 8 in Appendix 11. We find convexity ($\beta_{SD^2} > 0$) for the majority of observations and approximately 29% of U-shaped response curves ($\beta_{SD^2} > 0$ and $\beta_{SD} \approx 0$). Individual response patterns are also displayed in Figure 7 in Appendix 11.

4.2.2 Hypothesis 2: The treatment effect

In Hypothesis 2 (treatment effect), I test for a difference in the chosen activity level between baseline section and treatment section. Specifically, I am interested whether the participants choose on average lower activity levels in the baseline section of the data.

---

9 For a complete analysis, the results from the same linear regressions, conducted on the treatment data, are printed in Table in Appendix 11. As suggested by Figure 3 the findings do not differ much. The coefficient of squared standard vagueness is slightly smaller than in the baseline section, showing less convexity. This small difference can be found in Figure 3 as well: average activity choice levels are higher in the baseline data than in the treatment data at vagueness levels of SD300 and SD500, and lower at SD400.
Table 1: Effect of standard vagueness and squared standard vagueness on the activity choice in the baseline data

<table>
<thead>
<tr>
<th>Activity choice</th>
<th>Activity choice</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model 1 (OLS)</strong></td>
<td><strong>Model 2 (OLS)</strong></td>
</tr>
<tr>
<td>$SD$</td>
<td>$SD$</td>
</tr>
<tr>
<td>$-0.6762^{***}$</td>
<td>$-0.5032^{***}$</td>
</tr>
<tr>
<td>$(0.0766)$</td>
<td>$(0.1106)$</td>
</tr>
<tr>
<td>$SD^2$</td>
<td>$SD^2$</td>
</tr>
<tr>
<td>$9 \times 10^{-4}^{***}$</td>
<td>$7 \times 10^{-4}^{***}$</td>
</tr>
<tr>
<td>$(2 \times 10^{-4})$</td>
<td>$(2 \times 10^{-4})$</td>
</tr>
<tr>
<td>Risk Preferences</td>
<td>Risk Preferences</td>
</tr>
<tr>
<td>$-3.4687^{**}$</td>
<td>$-3.4687^{***}$</td>
</tr>
<tr>
<td>$(1.6052)$</td>
<td>$(1.6052)$</td>
</tr>
<tr>
<td>(Intercept)</td>
<td>(Intercept)</td>
</tr>
<tr>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>(set within the model)</td>
<td>(set within the model)</td>
</tr>
</tbody>
</table>

*: $p < 0.10$; **: $p < 0.05$; ***: $p < 0.01$

(without a second player), than in the treatment section of the data (affected second player).

For the overall comparison of activity level choices in the baseline and treatment section of the experiment, I regress the level of standard vagueness and squared standard vagueness on the activity level and interact them with a dummy variable, which takes the value 0 in the baseline section and the value 1 in the treatment section. While the coefficients hint at the hypothesized direction of the treatment effect, the difference is small and not significant. Therefore I cannot conclude that activity levels differ between baseline and treatment section and do not find sufficient evidence to accept Hypothesis 2. The results are displayed in Table 2.

### 4.2.3 Hypothesis 3: Undercompliance in the treatment section

Hypothesis 1 and Hypothesis 2 are concerned with the effect of vagueness increases and the introduction of an affected participant on the activity level. They are not concerned with the question whether activity takes place in the domain of overcompliance, undercompliance or at social efficiency. In line with the predictions from the theory chapter, Hypothesis 3 (undercompliance) states that activity choices will be undercompliant at all levels of standard deviation in the treatment condition. Graphically, the left panel in Figure 3 in the previous section already illustrates that activity choices in baseline and treatment section do not lie in the domain of undercompliance (above 500). This intuition is confirmed in the results in Table in Appendix 11. I regress standard vagueness and squared standard vagueness on the choice variable, while setting the intercept at the point of strict compliance (500). The results show that increases in standard vagueness reduce the chosen activity level below strict compliance, actually into the domain of overcompliance.

Hence, I do not find evidence in support of Hypothesis 3.
Table 2: Effect of standard vagueness and squared standard vagueness on the activity choice by treatment and social preference

<table>
<thead>
<tr>
<th></th>
<th>Activity choice (by treatment)</th>
<th>Activity choice (SVO)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 3 (OLS)</td>
<td>Model 4 (OLS)</td>
</tr>
<tr>
<td><strong>SD</strong></td>
<td>−0.6762***</td>
<td>−0.8283***</td>
</tr>
<tr>
<td></td>
<td>(0.0796)</td>
<td>(0.1559)</td>
</tr>
<tr>
<td><strong>SD²</strong></td>
<td>9 × 10⁻⁴****</td>
<td>0.0012***</td>
</tr>
<tr>
<td></td>
<td>(2 × 10⁻⁴)</td>
<td>(4 × 10⁻⁴)</td>
</tr>
<tr>
<td>treatment</td>
<td>−16.5744</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(13.169)</td>
<td></td>
</tr>
<tr>
<td>SD:treatment</td>
<td>0.1736</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.1473)</td>
<td></td>
</tr>
<tr>
<td>SD²:treatment</td>
<td>−3 × 10⁻⁴</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3 × 10⁻⁴)</td>
<td></td>
</tr>
<tr>
<td>SVO angle</td>
<td>−0.4224</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.5975)</td>
<td></td>
</tr>
<tr>
<td>SD: SVO angle</td>
<td>0.0137*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0081)</td>
<td></td>
</tr>
<tr>
<td>SD2: SVO angle</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0)</td>
<td></td>
</tr>
<tr>
<td>(Intercept)</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td>(set within the model)</td>
<td>(set within the model)</td>
</tr>
</tbody>
</table>

*: \( p < 0.10 \); **: \( p < 0.05 \); ***: \( p < 0.01 \)

4.2.4 Hypothesis 4: The effect of social preferences on the shape of the response function

In Hypothesis 4, I look at the effect of the seperately measured indicators of social preference on the shape and location of the response function. I conducted the slider task by Murphy, Ackermann, and Handgraaf (2011) in order to gain a standardized measure for social preferences in the sample. The observations lie between values of -7.565 and 45, indicating a range of preferences from perfectly individualistic to prosocial/efficient. The distribution is depicted in the left panel of Figure 4. In order to relate the findings to the model in this paper, I have associated the angle measure from the post test with crude categories of \( \beta \)-values, in accordance with the information provided by Murphy, Ackermann, and Handgraaf (2011). Perfectly individualistic preferences are associated with \( \beta = 0 \), preferences for social efficiency with \( \beta = 0.5 \) and maximin preferences correspond to \( \beta = 1 \).

In all evaluated theoretical models the type of social preference is predicted to alter the shape of the response curve. Specifically, it is predicted that individualistic preferences are associated with convexity and relatively lower activity choices on average. Prosocial preferences are associated with concave response curves and relatively higher chosen activity levels. Model 4 in Table 2 displays the results from regressing the standard
vagueness, squared standard vagueness, the angle measure for social preferences (SVO angle), as well as their interaction on the activity choice in the treatment section of the data. Standard vagueness as well as the squared term remain significant, with coefficients similar to those of previous models. Social preferences alone do not seem to have a significant effect, but the interaction with standard vagueness is significant at the 10-percent level. This indicates a less negative effect of standard vagueness at ‘more prosocial’ preferences. This finding is in line with the prediction of Hypothesis 4. Yet, I cannot find social preferences to alter the shape of the response function. While the coefficient of the interaction between the social preference measure and squared standard vagueness has the expected sign and magnitude, it is not significant. As I find social preferences to affect the level of the choice variable, but not its shape, I cannot fully accept Hypothesis 4.

But since there is an effect of social preferences, I proceed to inquire in the predictive power of the stated preference for the choice variable in the main part of the experiment. The right panel of Figure 4 delivers an insight into the predictive power. I generate predictions for the activity choice by plugging the individual $\beta$-values into the theoretical model. The results are plotted against the actual activity choice. Choices in which the social preference is consistent across the two tasks are found in close proximity to the 45°-line. Firstly, it can be seen that the majority of predictions based on the stated social preference are too high, indicating that social preferences are inconsistent across different tasks. Secondly, it can be seen that the predictive power decreases with standard vagueness. The latter finding could be indicative of a relationship between the lack of behavioral guidance through the law maker and the level of valuation of individual behavioral standards associated with fairness and prosocial conduct.

*Figure 4* Measured social value orientation and their impact on activity choice
4.2.5 Hypothesis 5: Increasingly erratic behaviour

In Hypothesis 5, I suggest that the variability of chosen activity levels increases as standard vagueness grows larger. This translates into increasingly erratic behaviour, an infrequently discussed byproduct of vague standards. As behaviour becomes more difficult to predict, the law looses in coordination power.

I define the variability in terms of the standard deviation of chosen activity levels, for each degree of standard vagueness. By means of a Jonckheere-Terpstra test, I reject that variability is constant over changes in standard vagueness, against the alternative, that it increases. Aside from the cost through overcompliance, as established in Hypothesis 3, we can therefore associate high levels of standard vagueness with a cost from the uncertainty for potential injured parties, as these adapt their behavior, become cautious or invest in insurance to brace for injury without restitution.

The results listed in Table 6 in Appendix 13 confirm the conjecture drawn from the right panel of Figure 3 in the data description. I therefore find strong support for Hypothesis 5.

5 Discussion

This paper investigates the effect of legal standard vagueness on the investment into taking precaution, as an effort to comply with the imposed behavioral standard. It therefore fits into the law and economics literature on compliance and deterrence. In the experimental literature it complements the vast body of literature on deterrence under uncertain or risky punishment conditions, by focusing on a scenario outside of the criminal framework. Here, the policy maker doesn’t want to minimise a certain type of behaviour, but rather induce efficiency and reduce any type of deviation from it.

Aside from re-testing the findings from HL, namely a U-shaped relationship between the investment in precaution and the degree of standard vagueness, this experiment investigates the interplay of vague standards with social consideration, when a participant’s actions impose an externality on a second participant.

While I do find convexity in the response function to the vague standard, I cannot replicate the U-shaped response function, moving from overcompliance to undercompliance, which had been reported by HL. Instead the activity choice decreases over the entire tested range of standard vagueness. Still, a more detailed analysis reveals that slightly less than a third of the participants make choices according to a U-shaped relationship.

The data also fails to present a treatment effect. Even after controlling for different degrees of social preferences, participants make similar choices in the baseline and the treatment section of the experiment.

A possible explanation for the flatter U-shape, the lack of a treatment effect and even the unexpected overcompliance in the treatment section can be found in theories of social psychology. Cognitive dissonance aversion (Festinger, 1957; Aronson, 1969; Konow, 2000) predicts that individuals prefer to reduce the 'dissonance' or psychological inconsistency
of their motivations and choices, by altering their behaviour.\textsuperscript{10} On the one hand, it is possible that participants who have made one or more overcompliant decisions, will be more inclined to make similar decisions at other vagueness levels. On the other hand, this theory might offer an explanation for the small treatment effect. Participants may experience cognitive dissonance between their self-interest for increasing their own payoff and fairness towards the affected second player. To reduce this unpleasant conflict, without reducing self-interested behaviour, the participant may engage in self-deception. The participant can do so by telling himself that the moral responsibility towards the second player is outsourced to the authority who sets and enforces the behavioural standard.

A further potential explanation for the results may be the design of the choice architecture which may have induced status-quo bias. Although the participants could freely choose the order in which they edited the scenarios, with and without an affected second player, most participants initially attended to the choice scenarios which did not involve a second player. By having already chosen an activity level for each level of standard vagueness in the non-second player scenario, participants might have provided their own anchor for the equivalent decision involving a second player. Experimental evidence documents the existence of anchoring in sequential decisions and also suggests that status-quo bias is particularly strong for large choice sets (Samuelson and Zeckhauser, 1988), such as the one in present experiment. Similar argumentation can be employed for the degree of vagueness. A metaphor for behaviour of the type states that a frog can be boiled if he is put into a pot with cold water and the temperature is increased just slowly enough. Yet, if the frog was placed into a pot of boiling water, he would jump right out. The gradual change of the vague standard might be responsible for preventing participant to detect the level at which a change in behaviour might be beneficial. As a suggestion for further research, the study might be replicated on a between subjects basis; that is, subjects choosing activity levels at differing levels of standard vagueness for either the second player scenarios or the non-second player scenarios.

While I can find an effect of social preferences on the activity choice, the results from the post test are only weak in predicting actual activity choices. On average, the employed data from the post test delivered predictions that were too high, suggesting that subjects were on average more prosocial in the post test, than in the main game. This might have to do with the relatively higher degree of complexity in the main task of the experiment. As a consequence, participants may have been preoccupied with the assessment of their own profit and potential liability, rather than the impact on another participant. This would also be in line with the finding that the predictive power of the measured social preference decreases with increasingly vague levels of the behavioral standard. Alternatively, the ambiguity of the social planner with regard to a behavioral

\textsuperscript{10} Of particular interest here is the literature on the experienced dissonance following a decision-making process. Early experimental evidence has been provided by Brehm (1956), who finds that individuals who were asked to reevaluate a difficult decision tend to reinforce their preference for the chosen option. The author asked individuals to rate two appliances and then choose between them. When the individuals were asked to rate them again, the individuals emphasised the positive attributes of their chosen option and attenuated the negative aspects.
standard might induce disregard of intrinsic behavioral standards.

Finally, I confirm the intuition from HL regarding the existence of a further hidden cost to standard vagueness. When the behavior of one party becomes increasingly erratic, it becomes very difficult to anticipate for society. The consequence may be the excessive investment in insurance through the potential bearer of an externality or a state entity. This finding is partially explained by diverging, distinctive patterns in behavior.

6 Conclusion

With the experiment in this paper I offer a contrasting view to Calfee and Craswell’s (1986) results, as well as to the experimental evidence by Hoeppner and Lyhs (2015). In fact, the results offer empirical support to the argumentation of legal scholars, who claim that the increase of legal uncertainty leads to the erosion of socially beneficial activity levels. The data doesn’t hint at the presence of a desirable alternative to legal certainty and provides two arguments for the systematic reduction of legal standard vagueness: On the one hand inefficiency (in terms of overcompliance) increases with standard vagueness, and on the other hand choice behavior becomes more erratic and less predictable. The latter expense is discussed less frequently, but can be very high: if the passive parties can invest in precaution and insurance they will invest according to their idea of the choice maker’s level of compliance.

It looks as if individuals do not distinguish between situations in which they saliently harm another individual and those in which they don’t. This can serve as an explanation for the prevalence of defensive behavior in principal-agent relationships in which agents forego the best action, out of fear of liability. Instead, individual social concerns even seem to lose priority when individuals are confronted with a vague standard. This result indicates that law makers cannot rely on the intrinsic motivation which generates socially desirable outcomes in a variety of other scenarios. Whether this is due to dealing with increasingly complex situations or an adverse signalling effect is unclear.

Despite the divergence to previous results, this study further highlights the sensitivity to legal standard vagueness and should raise awareness amongst law- and policy makers. It should also provide the motivation to investigate into the perception of, and the reaction to standard vagueness in the field and in more clearly defined legal situations, such as medical malpractice or tax compliance. This might offer further insight into the reaction to vague standards in different contexts of social proximity and holds the potential of reducing society’s cost of defensive behavior.
References


Figure 5 Over- and undercompliance including Rawlsian Preferences

Activity level, $x$

Degree of standard vagueness, $\sigma$

$\alpha = 0, \beta = 1$

Rawlsian Preferences

$x_s = 500$
Figure 6 Sample Screen of the Decision Screen in the Experiment
### Table 3: Results from the questionnaire

<table>
<thead>
<tr>
<th>Self-reported math level</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;What level of math do you still feel comfortable with?&quot;</td>
<td>basic arithmetic operations (written)</td>
<td>basic arithmetic operations (mental arithmetic)</td>
<td>percent &amp; fractions (written)</td>
<td>percent &amp; fractions (mental)</td>
<td>optimization problems (written)</td>
</tr>
<tr>
<td></td>
<td>6.6%</td>
<td>14.5%</td>
<td>32.9%</td>
<td>23.7%</td>
<td>22.4%</td>
</tr>
<tr>
<td>Understanding</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>&quot;Do you feel that you understood the task in the main game?&quot;</td>
<td>&quot;I am not sure if I understood the task correctly.&quot;</td>
<td>&quot;No, I did not understand the task description.&quot;</td>
<td>&quot;Only partially.&quot;</td>
<td>&quot;Yes, but it wasn’t easy.&quot;</td>
<td>&quot;Yes, it was easy.&quot;</td>
</tr>
<tr>
<td></td>
<td>1.3%</td>
<td>0.0%</td>
<td>2.6%</td>
<td>35.5%</td>
<td>60.5%</td>
</tr>
</tbody>
</table>

### Table 4: Jonckheere-Terpstra test on changes in the activity choice

<table>
<thead>
<tr>
<th>Subset</th>
<th>Alternative Hypothesis</th>
<th>Test statistic (JT)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>Decreasing</td>
<td>34282</td>
<td>0.0014</td>
</tr>
<tr>
<td>Baseline</td>
<td>Increasing</td>
<td>34282</td>
<td>1</td>
</tr>
<tr>
<td>Treatment</td>
<td>Decreasing</td>
<td>34150</td>
<td>0.001</td>
</tr>
<tr>
<td>Treatment</td>
<td>Increasing</td>
<td>34150</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 5: Effect of standard vagueness and squared standard vagueness on the activity choice in the treatment data

<table>
<thead>
<tr>
<th>Activity choice</th>
<th>Activity choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1 (OLS)</td>
<td>Model 2 (OLS)</td>
</tr>
<tr>
<td><strong>SD</strong></td>
<td><strong>SD</strong></td>
</tr>
<tr>
<td>−0.622***</td>
<td>−0.4131***</td>
</tr>
<tr>
<td>(0.0827)</td>
<td>(0.1192)</td>
</tr>
<tr>
<td><strong>SD²</strong></td>
<td><strong>SD²</strong></td>
</tr>
<tr>
<td>8 × 10⁻⁴****</td>
<td>5 × 10⁻⁴****</td>
</tr>
<tr>
<td>(2 × 10⁻⁴)</td>
<td>(2 × 10⁻⁴)</td>
</tr>
<tr>
<td>Risk Preferences</td>
<td>−4.189*</td>
</tr>
<tr>
<td>(set within the model)</td>
<td>(1.7312)</td>
</tr>
<tr>
<td>(Intercept)</td>
<td>500</td>
</tr>
<tr>
<td>(set within the model)</td>
<td>500</td>
</tr>
</tbody>
</table>

*, p < 0.10; **, p < 0.05; ***, p < 0.01
**Figure 7** Individual choices in the baseline condition

![Graph showing individual choices in the baseline condition.](image)

<table>
<thead>
<tr>
<th>Choice by behavioural category</th>
<th>Ambiguity averse (~45%)</th>
<th>Ambiguity embracing (~6%)</th>
<th>Indifferent to ambiguity (~20%)</th>
<th>U-shaped (~29%)</th>
</tr>
</thead>
</table>
| Activity level                | Degree of standard vagueness (measured as standard deviation of the distribution)
Figure 8 Individual choices in the baseline condition, classified by their coefficients.

Table 6: Jonckheere-Terpstra test on changes in variability

<table>
<thead>
<tr>
<th>Subset</th>
<th>Alternative Hypothesis</th>
<th>Test statistic (JT)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>Increasing</td>
<td>59</td>
<td>0.001</td>
</tr>
<tr>
<td>Baseline</td>
<td>Increasing</td>
<td>15</td>
<td>0.003</td>
</tr>
<tr>
<td>Treatment</td>
<td>Increasing</td>
<td>15</td>
<td>0.003</td>
</tr>
</tbody>
</table>