On the Political Economy of Public Safety Investments

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Abstract

This paper explores the interaction of private precaution and public safety investments that are determined in a political process. We distinguish between a scenario in which the median-voter victim influences public safety and one in which the injurer lobbies the public agent, analyzing both negligence and strict liability with a defense of contributory negligence for each scenario. We establish that the levels of injurer and victim care are always socially optimal for the equilibrium level of public safety. However, the equilibrium level of public safety differs from its first-best level and drastically depends on both the specifics of the political process and the liability rule applied. This implies that, in contrast to results from the classic literature, the level of social costs is critically determined by the choice between liability rules (for a given political process).

Keywords: liability law, care levels, public safety, political economy, median voter, lobbying

JEL-Classification: K 13, D 72

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1 Introduction

1.1 Motivation and main results

The efficient management of expected harm requires the use and successful coordination of various precautionary inputs that may be provided by private and public agents. The commonly considered interaction between potential injurers and potential victims is indeed pervasively framed by choices of public agents about safety investments. This intertwining of private and public investments arises, for example, in the context of infrastructure and its use. The public agent may install lights or a railroad gate at a railroad crossing, thereby shaping the levels of precaution that can reasonably be expected from private parties. On residential streets, the government may vary the number of zebra crossings and thereby influence both the behavior of potential victims and injurers and the traffic accident risk. Similarly, the risk posed by trucks on highways will be a function of the care exerted by drivers and the maintenance efforts of the government agency responsible for highways. The meshing of private and public safety investments also shows in other contexts. For example, the public agent chooses the capacity of the fire department and other emergency services, moderating the incentives of potential injurers (such as chemical plants) and potential victims (such as residential neighbors of the chemical plant) to take precautions on their own. A similar interaction may be at work when agencies screen products before they are marketed, because innovating firms as potential injurers and consumers as potential victims will respond to the quality of the screen of the agency with adjustments in their precautionary investment.

This paper analyzes the interaction of public safety investments and private precautions, focussing on the repercussions of the political dimension of public safety investments. The levels of private precaution are chosen by potential injurers and victims subject to a liability rule, either strict liability with a defense of contributory negligence or simple negligence\(^1\). The level of public safety investment is set by a public agent. When public agents are involved, it is interesting to explore how they arrive at decisions. Political economy arguments

\(^1\)We choose strict liability with a defense of contributory negligence and simple negligence, because both achieve efficient care in the standard setting and the injurer (victim) bears expected harm under the former (latter).
suggest that public agents – like any other agents – seek to maximize an objective function subject to constraints, where these constraints arise from the applicable political process in the given context (e.g., Mueller 2003). In order to focus on the additional element of our model (i.e., the public safety investments determined by a public agent), we contrast the findings of two standard political economy setups, the median-voter and a lobbying framework. Specifically, our analysis distinguishes the scenario in which the median-voter victim influences public safety from the one in which injurers lobby the public agent to modify public safety to their benefit (along the lines of Grossman and Helpman 1994). Our comprehensive approach regarding political processes seems reasonable, since the relative importance of parties’ interests for the public agent will vary according to the source of the expected harm considered. Some kinds of expected harm are simply more significant to potential victims than others; such salient issues may be explicitly addressed in the political agendas of candidates, whereas other issues may be more open to behind-the-scenes influence by lobbyists. For example, the decision about public safety investments at railroad crossing is relatively more likely to be relevant in elections than in lobbying activities by firms when compared to the screening of products.

For our analysis, we extend the bilateral-care framework with a third kind of precautionary input, namely public safety investment. The level of public safety is determined before the injurer and the victims simultaneously choose care subject to a liability rule. Potential victims vary in their level of expected harm and may thus have different valuations for a given level of public safety investment. The injurer optimizes against the distribution of victims, that is, cannot tailor injurer care to victim type. The expenditure on public safety investment is paid for by proportional income taxes. Due care standards used in liability rules are socially optimal care levels contingent on the circumstances created by public safety investment, the idea being that courts set the standard of care conditional on, for instance, the presence of warning signs or the quality of roads. To help us work out the the repercussions of the political dimension of the interaction between public safety investments and private care, we use a stylized setting. We will provide a discussion about possible limitations and potential avenues for further research in our discussion.
We find that both liability rules considered (i.e., strict liability with a defense of contributory negligence and simple negligence) induce potential injurers and victims to take private precautions that are socially optimal contingent on the level of public safety investments. In this sense, we maintain the results from the classic literature about the irrelevance of the liability rule chosen (e.g., Shavell 2007). However, the level of social costs that results under strict liability with contributory negligence will differ markedly from the one obtained under simple negligence when holding the political process constant. The divergence of the levels of social cost can be attributed to distortions in the level of public safety investments resulting from externalities introduced by the political economy of public safety investments. To see this, consider the median-voter victim setup. When the median-voter victim determines the level of public safety investments and simple negligence applies, distortions follow from that fact that the median-voter victim takes marginal effects (i.e., direct marginal benefit in terms of lower expected harm and marginal costs in terms of a higher tax burden) into account only insofar as they apply to him. Moreover, part of the motivation of the median-voter victim under negligence is to increase the care-taking of the injurer, because the due-care standard directed at the injurer is a function of public safety investments. When the median-voter victim determines the level of public safety investments and strict liability with a defense of contributory negligence applies, distortions follow from that fact that the median-voter victim considers more public safety investments to be desirable only to the extent that it lowers the standard of care directed at the median-voter victim. In other words, in this scenario, excessive public safety investment results when public precaution and victim care are strategic substitutes, that is, when more public safety investment lowers the costs of obeying the due-care standard for politically influential victims. Moving to the alternative political process – lobbying by the injurer – it can be established that the levels of public safety investments are very different, because the politically influential party in this context (i.e., the injurer) internalizes other marginal effects, while externalizing other ones. In summary, the central forces that drive the distortion of public safety investments include the lack of complete marginal internalization by policy-setting parties and the resultant existence of strategic effects of changes in the level of public precautions for the level of private costs.
The politically influential party seeks to redistribute some of its expected burden to the other party by means of its impact on the level of public safety. Importantly, the interests of the politically influential party are critically influenced by whether or not it bears the accident costs.

Our paper contributes to the literature in the following ways. First, we show that even though both negligence and strict liability induce optimal behavior by the private parties for given public safety investments, the two regimes affect the public investment and thereby the level of social costs differently. In this way, we contribute to the large literature on the preferability of negligence versus strict liability.\(^2\) It is shown that this results because the different liability rules create divergent public safety incentives for politically influential parties. This finding arises from the fact that, in equilibrium, a given party will be incentivized by the due-care standard under one liability rule, while being the residual bearer under the other. In addition, we clearly delineate how these incentives are shaped by the applicable political process for determining public safety investment.

### 1.2 Related literature

The present paper is related to articles addressing political economy aspects in the field of law, contributions dealing with the relationship between liability and regulation, and papers that consider multilateral care.

Some researchers have observed that the design and the functioning of law can be strongly affected by the political context. For example, Rubin (2005) discusses the ways in which the tort regime has been shaped by the influence of various organized groups such as lawyers, doctors, and businesses. Epstein (1988) and Rubin and Bailey (1994) provide related analyses. Rubin et al. (2001) compare litigation and lobbying as two alternative avenues for changing the law in common-law systems, both of which are open to any organized group. Our general interest – how the performance of policy instruments is influenced by the specifics of the political process – has been addressed in different streams of the literature. For example, in the area of environmental economics, van’t Veld and Shogren (2012) analyze the combination

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\(^2\)For a recent survey, see Schäfer and Müller-Langer (2009), for example.
of environmental federalism and environmental liability rules, finding that regions choose between liability rules and their design without internalizing all of the repercussions of these decisions. Focusing on environmental taxes instead of environmental liability, Fredriksson et al. (2010) consider the potential distortions arising from a majority bias, that is, the majority party’s favoring home districts over other districts. Such majority bias may rationalize a departure from the otherwise optimal federal district-level taxation. Related concerns also take center stage in the present contribution – namely, the fact that the party with the critical influence on the policy-setting public agent (either the injurer or the median victim) does not take into account all marginal effects.

In our paper, the government shapes the interaction between injurer and victim by setting the level of public safety. This may be interpreted as a form of regulation, since the government thereby influences the pros and cons of alternative courses of action. Shavell (1984a, b) has analyzed the case in which liability is plagued by disappearing defendant and judgment proofness problems and safety regulations do not achieve first-best outcomes because of their applicability across the board (i.e., without being tailored to the specifics of the case). These and subsequent contributions (e.g., Bhole and Wagner 2008, Kolstad et al. 1990, Rouillon 2008, Schmitz 2000) have often been principally concerned with providing an efficiency explanation for the widespread joint use of regulation and liability. In contrast, our paper takes this interaction for granted, instead seeking to explore how political influences on public intervention impact the efficiency of different liability rules.

In our contribution, there are three different precautionary inputs affecting expected harm, where public safety investments are determined in an earlier stage and in an observable fashion. The scenario in which different input-providing parties move in sequence and the question of whether or not liability rules are capable of inducing the first-best outcome in such a setting have been discussed in Endres (1992), Friehe (2009), Shavell (1983), Winter (1994), and Wittman (1981). Unlike these analyses, in our framework, the party moving first (the public agent) never bears expected harm. However, the political process effectively provides for the influence of either the injurer or the victim on the public agent’s determination of public safety. Nevertheless, public safety only provides an indirect influence on the
interaction between the injurer and the victim, as there is no level of public safety that can free the politically influential party (i.e., the level of care that will be compared to due care is set after the public safety investment is determined). Private precautions are determined simultaneously. This type of bilateral-care framework has been one of the mainstays of the economics of liability law since Brown (1973).

1.3 The plan of the paper

Section 2 describes our model and the characteristics of the socially optimal outcome (i.e., the one that results when the different levels of care are all determined by a benevolent planner). In the remainder of our paper, we are interested in the functioning of tort law in different political contexts. Accordingly, we analyze the incentives of private parties to take precautions that are produced by various liability rules (specifically, negligence and strict liability with a defense of contributory negligence) in different political environments. In Section 3, we consider public safety investments and the functioning of liability rules when the level of public safety is determined by a simple majority rule, where the population of potential victims represents the electorate. In Section 4, we analyze an alternative scenario in which injurers lobby the public decision-maker in order to align the level of public safety investments with their objectives. Again, the analysis differentiates between scenarios in which injurers and victims are subject to negligence and settings under strict liability with contributory negligence. Section 5 provides a brief discussion and concludes the paper.

2 The model and the social optimum

2.1 Model

Our model is populated by three kinds of risk-neutral parties: the injurer, a public agent and a population of victims. The injurer undertakes a socially desirable activity that imposes expected harm. The injurer, victims, and the public agent can all implement measures to

\[3\text{In the section on voting by potential victims, we effectively consider a political competition between two public agents, where one agent’s platform eventually attracts the majority of votes.}\]
influence the level of the expected harm. Injurer precaution is denoted by $x \geq 0$, victim care by $y \geq 0$, and public safety is represented by $z \geq 0$. The costs of care are simply $x$, $y$, and $z$, respectively. Victims differ in their level of exogenous income, denoted $\theta$, where $\theta \in [\underline{\theta}, \bar{\theta}]$ is distributed according to the cumulative density function $F$. The expected harm affecting a victim with income $\theta$ is assumed to be proportional to income and is given by $l(x, y, z)\theta$. This reflects the fact that the harm incurred in an accident is often some function of the material wealth of the affected individuals, as in cases in which harm impacts the individual’s property or health (via lost earnings). The function $l(x, y, z)$ is strictly decreasing at a diminishing rate in all of its arguments (i.e., $l_j < 0$ and $l_{jj} > 0 \ \forall j = x, y, z$) and is strictly convex (the implications of this are detailed in the Appendix). The initial impact of each kind of precaution on the level of $l$ is considerable, such that $\lim_{j \to 0} l_j = -\infty$ whereas $\lim_{j \to \infty} l_j = 0$. This ensures interior solutions for the three kinds of precaution.

With respect to the level of expected harm, we consider the possibility that the three different safety measures act as substitutes, complements, or do not interact. When two care measures are substitutes (complements), this connotes that an increase in one kind of care decreases (increases) the marginal productivity of the other kind of care in reducing the level of expected harm. Alternatively, the marginal productivity of a kind of care may be unaffected by other precautionary investments. The literature has convincingly established that all cases are relevant in real-world examples (see, e.g., the discussion in Friehe and Tabbach 2014). Such relationships will be important for our analysis. We consider all possible scenarios regarding the interactions of injurer and victim care and of private care and public safety investments (i.e., they may be substitutes or complements), but assume that the influence of more public investment is the same for both kinds of private precaution (i.e. $x$ and $y$ are both either substitutes or complements for $z$) in order to limit the number of cases.

2.2 Social optimum

The benevolent policy-maker chooses injurer care, victim precautions, and public safety investments to minimize the sum of expected harm and precaution expenditures. One level
of both \( x \) and \( z \) applies to all victim types; that is, injurer and public precaution cannot be tailored to individual victims. This also implies that the precaution of the injurer and that of the government may be interpreted as durable, as they are applicable to many potential interactions (see, e.g., Nussim and Tabbach 2009).

The first-best allocation that takes this realistic restriction into account follows from

\[
\min_{x,y(\theta),z} \ SC = x + \int_{\theta}^{\bar{\theta}} [y(\theta) + l(x, y(\theta), z)\theta] \, dF(\theta) + z. \tag{1}
\]

Given the convexity of \( l \), the first-order conditions are necessary and sufficient to characterize the unique socially optimal outcome defined by

\[
1 + \int_{\theta}^{\bar{\theta}} l_x(x^*, y^*(\theta), z^*)\theta \, dF(\theta) = 0 \tag{2}
\]
\[
1 + l_y(x^*, y^*(\theta), z^*)\theta = 0 \forall \theta \in [\theta, \bar{\theta}] \tag{3}
\]
\[
1 + \int_{\theta}^{\bar{\theta}} l_z(x^*, y^*(\theta), z^*)\theta \, dF(\theta) = 0. \tag{4}
\]

The system \([2]-[4]\) is solved by \((x^*, y^*(\theta), z^*)\), where \( \theta \in [\theta, \bar{\theta}] \); this represents the efficient care levels for our three kinds of agents and yields minimal social cost \( SC^* = SC(x^*, y^*(\theta), z^*) = \min_{x,y(\theta),z} SC \).

The marginal costs of care are equal to one for injurer care, victim precautions, and public safety investments. In contrast, the marginal benefits of care are contingent on whether it involves the precaution taken by an injurer, victim, or the public agent. The marginal benefit of injurer care is the average marginal decrease in the expected harm of the entire population of victims. The marginal impact of more injurer care varies for different victim types. Socially optimal victim care is type-specific and increases with exposure to risk (i.e., income), as follows from \( [3] \). The condition for first-best public safety investment is similar to that for injurer care, in that the same level applies to all victims. Again, the marginal impact of more public safety varies for different victim types.

Next, we analyze the decentralization of decision-making when private parties are subject to one of two liability rules, either negligence or strict liability with a defense of contributory negligence, focusing on the influence of the political process for the outcome in terms of care levels and the level of social costs.
3 Public safety investment influenced by potential victims

In this section, we will consider the scenario in which the level of public safety investment is influenced by potential victims through electoral politics. More specifically, we assume that the level of public safety investment follows from the preferences of the median-voter victim.\(^4\) In other words, the public agent is no longer a benevolent planner but is instead only concerned with receiving the majority of votes. In our model, the policy space comprises both the level of public safety investment and the level of the proportional income tax required for financing; however, the fact that the latter is a function of the former via the budget constraint makes the election a single-issue one. In this election, public agents first announce their preferred combination of public safety and income tax, and are bound by their decision when they are later voted in office (i.e., there is full commitment).

Our analysis will differentiate between the scenario in which injurers and victims are subject to negligence and the one in which they are subject to strict liability with contributory negligence. The game involves strategic interactions between the injurer and the victims and between the private parties and the public agent. However, there is no strategic interdependence among potential victims.\(^5\) This last factor follows from the assumption that a victim’s investment in safety influences only his or her personal expected harm and not that of other victims.

3.1 When negligence applies

When negligence applies, we make the following assumptions regarding the timing of decisions and the information available: In the first stage, the level of public safety investment is determined in the political process (clarified below). The due-care standard that is addressed to the injurer under negligence is denoted by \(x_s\) and is assumed to be equal to the socially

\(^4\)This will be the political outcome when two public agents compete for a simple majority in a single-issue election when voters have single-peaked preferences and the distribution of voters is unimodal (e.g., Mueller 2003). We assume that these characteristics apply and will discuss the shape of victims’ preferences explicitly below.

\(^5\)For an alternative framework, see Friehe (2012).
optimal injurer care level for the given level of public safety; that is, it follows from solving (2)-(3) for the given level of $z$. As a result, the selection of the public safety investment at stage 1 co-determines the due-care standard relevant at the second stage. This assumption is motivated by the fact that courts in fact make their decision about due care conditional on the circumstances and will apply throughout the rest of this paper. Obeying the due-care standard relieves the injurer from the duty to compensate the victim for harm incurred. In stage 2, both private parties determine their precautions, taking the level of due care and the level of public safety investment into account. We solve the game by backward induction.

At the second stage, the injurer determines whether or not to obey the due-care standard for the given level of public safety investment, based on the following private cost function:

$$IC_N = \begin{cases} x + \int_\theta^\theta l(x, y(\theta), z) \theta dF(\theta) & \text{if } x < x_s \\ x & \text{if } x \geq x_s \end{cases} \tag{5}$$

The first line is minimized by the socially optimal response to given care by the population of victims. The second line is minimized by $x_s$. Similarly, for the given level of public safety investment, the victim with income $\theta$ chooses the care level that minimizes

$$VC_N = \begin{cases} y & \text{if } x < x_s \\ y + l(x, y, z) \theta & \text{if } x \geq x_s \end{cases} \tag{6}$$

It is cost-minimizing for the victim to choose no care when the injurer disobeys the due-care standard. By standard reasoning, the Nash equilibrium of the subgame represented by stage 2 is such that the injurer abides by the standard $x_s = x(z)$ (which satisfies the condition equivalent to (2) for any given $z$) and the victim with income $\theta$ chooses a level of care $y(\theta, z) = \arg \min_y [y + l(x, y, z) \theta]$ (which satisfies the condition equivalent to (3) for any given $z$). As a result, each party selects a care level that is socially optimal for the given level of public safety investment previously selected. This result is summarized in:

**Lemma 1** Assume that negligence applies and and that the efficient due-care standard is set for the given level of public safety investment (i.e., $z$). Then, the injurer and the victims choose efficient levels of injurer and victim precaution for any given level of public safety.

Before turning to the first stage, it is useful to examine how the care levels selected by the private agents in stage 2, $x(z)$ and $y(\theta, z)$, respond to changes in the level of public
investment determined in stage 1. The care levels chosen at stage 2 (one of which is equal to the due-care standard) are by Lemma 1 the socially optimal levels described in (2) and (3), where the care choice of the injurer is guided by the court’s adaptation of the due-care standard. We must therefore evaluate

$$\int \theta \left[ l_{xx}(x, y(\theta), z) \frac{dx(z)}{dz} + l_{xy}(x, y(\theta), z) \frac{\partial y(\theta, z)}{\partial z} + l_{xz}(x, y(\theta), z) \right] \theta dF \right] dz = 0 \quad (7)$$

$$\int \theta \left[ l_{xy}(x, y(\theta), z) \frac{dx(z)}{dz} + l_{yy}(x, y(\theta), z) \frac{\partial y(\theta, z)}{\partial z} + l_{yz}(x, y(\theta), z) \right] \theta dF \right] dz = 0. \quad (8)$$

The change in the level of injurer care in response to a variation in the level of public safety is not a function of $\theta$, as injurer care is determined in view of the entire population of victims. In contrast, the way in which victim care changes when public safety increases may be type-specific. This leads to

$$\frac{dx(z)}{dz} = \int \theta \left[ l_{yy}^{-1} \left[ l_{yy} l_{yz} - l_{xx} l_{yy} \right] \theta dF \right]$$

$$\frac{\partial y(\theta, z)}{\partial z} = -l_{yy}^{-1} \left[ l_{yz} + l_{xy} \frac{dx}{dz} \right]. \quad (9)$$

Note that the denominator of $dx/dz$ is positive by the convexity of $l(x, y, z)$ (for greater detail, see the Appendix). Thus, the influence of a change in public safety on the optimal level of injurer and victim care results from two effects, one direct and the other indirect.

The direct effect on injurer care results from the influence of higher public safety on the marginal productivity of injurer care in reducing expected harm (i.e., $l_{xz}$). The indirect effect on injurer care results from the influence of higher public safety on the marginal productivity of victim care (i.e., $l_{yz}$) and the repercussions of the implied change in the level of victim care for the marginal productivity of injurer care (i.e., $l_{xy}$). This demonstrates that the comparative-statics results critically depend on the relationship between private care and public care, as well as on the relationship between injurer and victim care. When injurer and victim care are complements (i.e., when $l_{xy} < 0$), the direct and the indirect effect will go in the same direction. However, the two effects go in opposite directions when injurer and victim care are substitutes with respect to lowering expected harm (i.e., when $l_{xy} > 0$).
For the analysis that follows, it is useful to arrive at sufficient conditions for whether private care and public safety are complements or substitutes. The following lemma presents such conditions, using the statements in (9) and (10). (The proof of this result and those that follow are relegated to the Appendix.)

**Lemma 2**

1. Assume \( l_{xy} \leq 0 \). Private care and public safety are strategic complements (substitutes) when \( l_{jz} < (>0) \) for \( j = x, y \).

2. Assume \( l_{xy} > 0 \). Private care and public safety are strategic complements (substitutes) when \( l_{jz} < (>0) \) for \( j = x, y \) and the direct effect of a change in \( z \) dominates.

3.1 Assume \( l_{xy} > 0 \) and \( l_{jz} < 0 \). Injurer care and public safety are substitutes and victim care and public safety are complements when the indirect effect of a change in \( z \) dominates.

3.2 Assume \( l_{xy} > 0 \) and \( l_{jz} > 0 \). Injurer care and public safety are complements and victim care and public safety are substitutes when the indirect effect of a change in \( z \) dominates.

The comparative-statics results of private care when public safety investments change depend only on how the productivity of private care is influenced by public care (i.e., \( l_{jz} \)) when the two kinds of private care are complements or are independent of each other in their influence on the level of expected harm (i.e., \( l_{xy} \leq 0 \)). As a result, we obtain both \( dx(z)/dz > 0 \) and \( \partial y(\theta, z)/\partial z > 0 \) when \( l_{jz} < 0 \). A higher level of public safety investment increases the marginal productivity of own care, thereby calling for greater investment. The implied change in the level of care of the other private party is inconsequential or supportive, depending on whether \( l_{xy} < 0 \) or \( l_{xy} = 0 \). In contrast, when injurer and victim care are substitutes with respect to lowering \( l \) (i.e., when \( l_{xy} > 0 \) holds), we find that the direct effect and the indirect effect oppose each other. As a result, when the direct effect of a change in the level of public safety investment dominates, the sign of the change in private precaution is the same for both kinds of private care and depends on how public safety influences the marginal productivity of private care. When the indirect effect dominates, the changes in the levels of private care go in opposite directions.

At the first stage, the level of public safety investment is determined. We assume that there is a political competition between two public agents who are bound by the policy
platform they announce before elections take place. Our electorate – the population of potential victims – is heterogeneous only with regard to the parameter $\theta$. The level of minimized private costs of the median victim with income $\theta_m$ follows from

$$
\min_z VC^N(z, \theta_m) = y(z, \theta_m) + l(x(z), y(z, \theta_m), z)\theta_m + \tau \theta_m,
$$

(11)

where $\tau$ represents the tax rate implied by the expenditure $z$, following from

$$
z = \tau \int_\theta^\theta \theta dF = \tau E.
$$

(12)

Substituting $\tau = z/E$ from (12), the privately optimal level of public safety investment for the median victim satisfies $\frac{\partial}{\partial z} VC^N(z, \theta_m) = 0$ (assuming an interior solution and $\frac{\partial^2}{\partial z^2} VC^N(z, \theta_m) > 0$), where

$$
\frac{\partial}{\partial z} VC^N(z, \theta_m) = \left[ l_x(x(z), y(\theta_m, z), z) + l_z(x(z), y(\theta_m, z), z) \right] \theta_m + \theta_m/E,
$$

(13)

using the envelope theorem to simplify the expression. Term A reflects the median-voter victim’s consideration that a change in public safety will affect the level of care required from the injurer via the due-care standard. This is a strategic effect absent in the trade-off of the benevolent policy-maker, implying a potential divergence between privately and socially optimal public safety. However, this strategic effect presents an argument for public safety investments only when public safety and injurer care are strategic complements (i.e., when $dx/dz > 0$). Term B represents the direct effect of increased public safety on the median victim’s expected harm level. The median victim’s abstraction from the influence of public safety investment on other victims’ expected harm may also result in a divergence between privately and socially optimal public safety. Depending upon how the marginal productivity is influenced for different victim types, this may entail an underestimation or an overestimation of the marginal benefits of public safety. Finally, the term $\theta_m/E$ represents the marginal cost of increasing the investment in public safety for the median victim relative to the marginal costs for the average potential victim. This ratio will be less than one when the median victim has less than average income. This would imply that the victim
underestimates the marginal costs of public safety investment due to the fact that the bulk of tax payments are made by better-off victims.

In order to explore how the preference for public safety investment depends on the level of income, we take the derivative of (13) divided by $\theta_m$ with respect to $\theta_m$ (thereby assuming an interior solution for $z$):

$$\frac{\partial^2 VC^N}{\partial z \partial \theta_m} = \left[ l_{xy}(x(z), y(z, \theta), z) \frac{dx}{dz} + l_{yz}(x(z), y(z, \theta), z) \frac{dy}{\partial \theta_m} \right],$$

with $\frac{\partial y}{\partial \theta} > 0$ (see condition (3)). The change in injurer care induced by a variation in public safety is not influenced by the identity of the victim we consider here (i.e., $dx/dz$ remains the same). The derivative in (14) may be used for the following lemma, stating how the valuation of public safety investments changes with the level of income (for interior solutions):

**Lemma 3**

1. Assume $l_{xy} \leq 0$. Victims with higher income prefer more (less) public safety when $l_{jz} < (>) 0$ for $j = x, y$.
2. Assume that $l_{xy} > 0$ and that the direct effect of a change in $z$ dominates in determining $dx/dz$. Victims with higher income prefer more (less) public safety when (i) $l_{yz} < 0$ and $|l_{xy} \frac{dx}{dz}| < (>) |l_{yz}|$ and (ii) $l_{yz} > 0$ and $|l_{xy} \frac{dx}{dz}| > (<) |l_{yz}|$.
3. Assume that $l_{xy} > 0$ and that the indirect effect of $z$ dominates in determining $dx/dz$. Victims with higher income prefer more (less) public safety when $l_{jz} < (>) 0$ for $j = x, y$.

The result reported in Lemma 3 can be readily explained. In general, a victim with a higher level of income will select a higher level of victim care in stage 2 because the individual exposure to the accident risk is higher. The implications of this for the preference for public safety depend on the relationships between the different kinds of care. Consider, for example, the scenario described in (1). When public safety lowers the marginal productivity of private care (i.e., when $l_{yz} > 0$), then a richer victim will value the direct effect less (represented by a positive Term B). The fact that injurer care decreases with the public safety investment in this case is also less of a concern for a victim with higher income (represented by a positive Term A). In other words, both sources of marginal benefit from higher public safety are less
important for richer potential victims, because they rely to a greater extent on their own precautions.

The median-voter theorem may be applied under the assumption that voters have single-peaked preferences in the one-dimensional policy space and follow a unimodal distribution. As argued above, the policy space in our framework is defined by the different levels of public safety investment. Single-peakedness results when \( [14] \) changes its sign at most once.

We summarize our analysis of behavior under negligence as follows:

**Proposition 1** Assume that negligence applies. The level of public safety that is optimal for the median victim may exceed or fall below the socially optimal level because:

1. The median victim underestimates the marginal costs of public safety when \( \theta_m/E < 1 \), and overestimates them when \( \theta_m/E > 1 \).
2. The median victim strategically incorporates the influence on the due-care standard, a strategic effect that induces more (less) public safety when \( l_{xy} \frac{\partial x}{\partial z} < (>) 0 \).
3. The marginal effect of public safety is taken into account only for the median victim, rather than for the entire population of victims.

The level of public safety that minimizes the expected costs of the median voter is generally different from the level that minimizes social costs. Although this basic result will reemerge in the next section on strict liability with a defense of contributory negligence, the reason for the divergence between private and social marginal effects will be fundamentally different.

### 3.2 When strict liability with a defense of contributory negligence applies

The sequence of events remains unchanged when compared to the previous section; the only difference is that private parties are subject to strict liability with a defense of contributory negligence when determining precaution at stage 2. This liability rule addresses a due-care standard denoted \( y_s(\theta) \) for each victim type. This due-care standard is the socially optimal

\[ \text{We focus on the case in which the court can observe victim type and can thus condition the due-care standard on this observation. Otherwise, the negligence rule would be preferable, as it places the due-care standard on each victim type.} \]
victim care level given the level of public safety; that is, it follows from solving (2) and (3). In other words, the determination of public safety investment at stage 1 will have repercussions for the due-care standard directed at potential victims in stage 2. Obeying this due-care standard ensures that the victim will receive compensation in the event of an accident.

At the second stage, the victim with income $\theta$ chooses the care level that minimizes second-stage costs ($\forall \theta \in [\underline{\theta}, \bar{\theta}]$)

$$VC^{SLCN} = \begin{cases} y & \text{if } y \geq y_s(\theta) \\ y + l(x, y, \theta) & \text{if } y < y_s(\theta) \end{cases}.$$ (15)

The first line is minimized by due care, the second by the socially optimal response to given care by the injurer and the public agent. The injurer determines care for given public safety and anticipated victim care, based on the following cost function: \footnote{We state (16) anticipating symmetric victim behavior with respect to compliance and non-compliance with due care.}

$$IC^{SLCN} = \begin{cases} x + \int_{\underline{\theta}}^{\theta} l(x, y(\theta), \theta)dF(\theta) & \text{if } y \geq y_s(\theta) \forall \theta \in [\underline{\theta}, \bar{\theta}] \\ x & \text{if } y < y_s(\theta) \forall \theta \in [\underline{\theta}, \bar{\theta}] \end{cases}.$$ (16)

The first line is minimized by the socially optimal response to given care by the victim and the public agent; the second line is minimized by zero. Once again, standard reasoning yields the observation that private parties will choose socially optimal levels of care.

**Lemma 4** Assume that strict liability with a defense of contributory negligence applies and that the efficient due-care standard for the given level of $z$ is prescribed. Then, the injurer and the victims choose efficient levels of injurer and victim precaution for any given level of public safety.

It follows from Lemma \footnote{17} that the conclusions regarding how private care responds to a change in the level of public safety derived for the case of negligence (that is, (9) and (10)) are similarly applicable in the present context. As a result, we can utilize the findings described in Lemma \footnote{2} for our subsequent analysis.

At the first stage, there is again political competition between two agents vying for public office. The electorate consists of victims, and the issue at stake is the level of public safety standard on the non-heterogeneous party.
investment financed by proportional income taxes. With respect to the previous analysis, the difference lies in the level of minimized private costs for a victim with income \( \theta_m \), which follows from

\[
\min_z VC^{SLCN}(z, \theta_m) = y(\theta_m, z) + \tau \theta_m
\]  

(17)
in the case of strict liability with a defense of contributory negligence, subject to the budget constraint (12). The major difference in the objective function of the potential victim with income \( \theta_m \) comes from the victim’s anticipation of being fully compensated for any harm incurred in stage 2. This removes expected harm from the objective function of the victim when it comes to determining the level of public safety investments in stage 1. The privately optimal level of public safety for a victim with income \( \theta_m \) thus follows from

\[
\frac{\partial}{\partial z} VC^{SLCN}(z, \theta_m) = \frac{\partial y(\theta_m, z)}{\partial z} + \frac{\theta_m}{E},
\]  

(18)

where again \( \tau = z/E \) due to (12). This shows that the single source of marginal benefit is based on the influence on the due-care standard directed at the victim in stage 2. When an increase in public safety increases socially optimal victim precaution in stage 2 (i.e., when \( \partial y/\partial z > 0 \)), all victim types agree that public safety should not be used, since this would only increase private costs (\( \frac{\partial}{\partial z} VC^{SLCN}(z, \theta) > 0 \)). According to Lemma 2, this always results when \( l_{xz} < 0 \) and either injurer and victim care are complements or they are substitutes and the marginal effect is driven by the direct effect. In the alternative scenario in which \( \partial y/\partial z < 0 \), it becomes interesting to determine whether potential victims can be arranged according to their interests in public safety in a manner amenable to the median-voter theorem, where the condition for the interior level of public safety can be rearranged to

\[
-\frac{\partial y(z, \theta_m)}{\partial z} = \frac{\theta_m}{E}.
\]

Note that the marginal costs of victims with a higher income are necessarily greater in this regime. With respect to the marginal benefit, the effect is unclear. Specifically, when the due-care standard directed at potential victims with higher income levels reacts less strongly to a change in public safety than that of potential victims with low income, we find that the marginal benefits of public safety are lower for richer individuals. In contrast, when the due-care standard directed at potential victims with higher income levels reacts more strongly to a change in public safety than that of potential victims with low income,
then it is key whether or not marginal benefits outpace the increase in marginal costs.

Starting from (10), we obtain
\[
\frac{\partial^2 y}{\partial z \partial \theta} = -\frac{\partial y}{\partial \theta} l^{-2} \left[ \left( l_{yyz} + l_{xyy} \frac{dx}{dz} \right) l_{yy} - l_{yyy} \left( l_{yz} + l_{xy} \frac{dx}{dz} \right) \right].
\] (19)

This may be used to arrive at the following result:

**Lemma 5** Assume that strict liability with a defense of contributory negligence applies and that third derivatives are negligible in magnitude. Then, victims with higher income prefer (weakly) less public safety.

The incentives for public safety are drastically different under strict liability with a defense of contributory negligence in comparison to the case of negligence studied in the previous section. Under negligence, it was a possible outcome that potential victims with a higher level of income would prefer a higher level of public safety investments. This is ruled out under the present circumstances. The fundamental reason underlying this difference is that under strict liability, victims are fully compensated by the injurer in the event of an accident, which makes potential victims ignore the repercussions of public safety on the level of expected harm. With regard to the level of public safety investment determined in stage 1, we thus obtain the following result (relying principally on (18)):

**Proposition 2** Assume that strict liability with a defense of contributory negligence applies. The level of public safety that is optimal for the median victim (i) will be equal to zero when \( \frac{\partial y}{\partial z} > 0 \), or (ii) may be positive when \( \frac{\partial y}{\partial z} < 0 \), where a positive level of public safety becomes more likely as the median victim becomes poorer.

In the present context, victims with a higher level of income perceive a higher marginal cost, whereas the marginal benefit is likely to be to be relatively stable across different income levels. As a result, it is more likely that the given marginal benefit will suffice to make an interior public safety level privately optimal for the median victim when the income level of the median victim is relatively low.
This concludes our discussion of the scenario in which the median-voter victim effectively determines the level of public safety implemented by the public agent. In the next section, we consider the diametrically opposed scenario in which the injurer steers public safety investment in his favor by lobbying the public agent.

4 Public safety investment influenced by injurer lobbying

Potential injurers seek to influence regulatory outcomes to their advantage in many areas. Given the wide array of uses for political donations (such as funding election campaigns, retiring debt from previous elections, and deterring rivals), it is reasonable to assume that donations indeed influence government decisions (Damania 2001). For example, the empirical analysis by Fredriksson and Wollscheid (2008) is consistent with a model in which firms make financial contributions to policy-makers in order to lower demands regarding pollution abatement. This basic idea will also be our concern in this section, in which we follow contributions to the literature such as Grossman and Helpman (1994) and Damania (2001). The injurer can lobby the public agent in office who cares about political contributions and, possibly, welfare. Lobbying can be represented by a monetary transfer $S$ from the injurer to the public official when the latter is implementing the level of public care $z$.

The timing of events in our analysis is as follows. In the first stage, the political equilibrium is obtained: the injurer at first proposes a transfer $S$ to the public agent, and the public agent then chooses a level of public safety $z$ in response to the proposed $S$ in order to maximize his payoff. In stage 2, the injurer and the potential victims determine their private precaution, taking the level of public safety investment and the due-care standard into account; the due-care standard will be directed either at the firm or the victim, depend-

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8We continue to assume that the resources required for public safety investment will be raised via taxes from the population of victims (as we imagine the injurer to be a firm). In other words, the government uses income taxation of individuals to finance its activities, and the injurer influences the public agent to steer decision-making about government activities in its favor. Therefore, we abstract from the possibility that potential victims also impact the level of public safety investments (apart from their role in welfare) in order to make the contrast between the present section and the previous one about the median-voter victim as marked as possible.
ing on the liability rule. Again, the analysis distinguishes the scenario in which injurers and victims are subject to negligence from the one in which they are subject to strict liability with contributory negligence. We will address the former case first.

4.1 When negligence applies

Solving the game backwards, we first analyze the stage in which injurer and victim simultaneously determine their levels of care for a given level of public safety investment. Under negligence, the due-care standard is directed at the injurer. It is straightforward to verify that the subgame corresponding to stage 2 has the same equilibrium as the one detailed in Section 3.1; that is, the injurer and the victims choose the first-best levels of care for the given $z$. This connotes that the injurer anticipates taking due care and being freed from the obligation to compensate harmed victims in stage 2 when influencing political decision-makers in stage 1. In this outcome, the injurer bears only the costs of taking the standard of care. This allows us to turn directly to the analysis of the first stage.

In stage 1, the political equilibrium is obtained. The microstructure is such that the injurer first proposes to the public agent a contribution $S(z)$ that is a function of the implemented level of public safety. Knowing $S(z)$, the public agent chooses a level of public safety $z$ to maximize his payoff. Both the injurer and the public agent take into account the levels of injurer and victim care that result in stage 2, $x(z)$ and $y(z)$, as a function of the level of public safety investment.

We start with the decision of the public agent and assume that the public agent cares about political contributions and, to some relative extent $\alpha > 0$, about social costs (e.g., Grossman and Helpman 1994). Given a contribution schedule $S(z)$, the public agent chooses a level of public safety $z$ that minimizes

$$G(z) = \alpha SC(z) - S(z).$$

(20)

From (20), it follows that the public agent will increase the level of $z$ when $\alpha dSC/dz - dS/dz < 0$ applies, that is, when the marginal increase in contributions dominates any possible marginal increase in social costs up to the point where $\alpha dSC/dz = dS/dz$, that is,
where
\[
\alpha \left[ 1 + \int_{\theta} l_z(x, y(\theta), \hat{z}) \theta dF \right] = \frac{dS}{dz}
\] (21)

after making extensive use of the envelope theorem. This connotes that the public agent will choose the socially optimal level of public safety when there are no lobbying contributions, but may be incentivized to implement less or more than that depending on the curvature of \(S(z)\). In order to deter the public agent from marginally increasing \(z\) in this range (if this is desired by the injurer), the injurer would have to implement a decrease in the level of contributions in the relevant range, such that \(dS/dz < 0\). Accordingly, the magnitude of \(dS/dz\) can be interpreted as measuring the distortion away from the social optimum that results from the injurer’s lobbying the public agent.

The injurer understands that the public agent chooses the level of public safety to fulfill (21). By the adequate choice of a contribution schedule \(S(z)\), he can thereby induce a specific level of public safety. For any \(S(z)\) selected, the resulting level of public safety should minimize injurer’s private costs,

\[IC^N = x(z) + S(z),\] (22)

such that
\[- \frac{dx}{dz} = \frac{dS}{dz}\] (23)

must hold in equilibrium. This connotes that the injurer will transfer his full marginal benefit from the marginal change in \(z\) to the public agent via the marginal increase in contributions.\(^9\) The marginal benefit of the injurer is determined by the marginal change in the due-care standard, which reflects either the substitutability or the complementarity between private and public precaution. Indeed, when the due-care standard is increasing in the level of public safety due to complementarity, then the injurer pays contributions in order to achieve a level of public safety below the socially optimal level. To achieve this, the contributions must be

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\(^9\)In the terminology of Bernheim and Whinston (1986), the political contribution schedule is therefore \emph{locally truthful}. In absolute levels, the minimization of the injurer implies that \(S(\hat{z}) = \alpha(SC^* - SC(\hat{z}))\) when \(\hat{z}\) denotes the equilibrium public safety (see also, e.g., Grossman and Helpman 1994). Hence, the political contribution level reflects the additional burden of social cost that injurers impose on society.
decreasing over the relevant range. When the due-care standard is decreasing in the level of public safety due to substitutability, then the injurer pays contributions in order to achieve a level of public safety above the socially optimal level. To achieve this, the contributions must be increasing over the relevant range. This can also be illustrated by combining (21) and (23) as,

$$\alpha \left[ 1 + \int_{\bar{\theta}}^{\theta} l_z(x, y(\theta), \hat{z})\theta dF \right] = -\frac{dx}{dz},$$

where the bracketed term on the left-hand side gives the first-order condition for $z$ known from Section 2. The left-hand side will be negative when the level of public safety is below its first-best level, which will arise in the political equilibrium when $dx/dz > 0$. The left-hand side will be positive when the level of public safety is above its first-best level, which will arise in the political equilibrium when $dx/dz < 0$.

Our main results follow from the condition determining public safety (24), and are summarized in the following proposition.

**Proposition 3** Assume that negligence applies. The level of public safety that results in a political equilibrium with lobbying by the injurer will be below its efficient level when $dx/dz > 0$. The public safety level implemented will be above its efficient level when $dx/dz < 0$.

Under the negligence rule that uses a first-best due-care standard, injurers obey the standard of care and ignore expected harm. As a result, benefits from public safety from the injurer’s standpoint may only arise when it lowers care costs in stage 2. This would occur when a higher level of public safety makes a lower level of injurer care socially optimal, due to public and private care being strategic substitutes in reducing the level of expected harm. This parallels the argumentation for strict liability with a defense of contributory negligence in the scenario in which potential victims shape public policy by voting.

4.2 When strict liability with a defense of contributory negligence applies

Under strict liability with a defense of contributory negligence, the victim determines whether or not to obey the due-care standard that is set at the efficient level. As a result, the outcome
of the interaction between the injurer and the victim in stage 2 is efficient care levels that solve (2) and (3) for given $z$. This implies that the injurer will bear the sum of both costs of care and expected harm as individual costs in stage 2.

In stage 1, the political equilibrium obtains. The sequencing in this stage is unchanged when compared to our analysis of negligence. Knowing $S(z)$, the public agent minimizes $G(z)$. Anticipating the decision-making of the public agent, the injurer selects a contribution schedule $S(z)$. The difference lies in the objective function that the injurer minimizes when choosing a contribution schedule $S(z)$. In this scenario, the level of injurer costs is

$$IC^{SLCN} = x(z) + \int_{\theta}^{\hat{\theta}} l(x, y(\theta), z) \theta dF + S(z), \tag{25}$$

because victims comply with the due-care standard at stage 2. The objective function of the public agent is still described by (20).

Following the same argumentation detailed in Section 4.1 and using both $dG/dz = 0$ and $dIC^{SLCN}/dz = 0$, that is,

$$\alpha \left[ 1 + \int_{\theta}^{\hat{\theta}} l_z(x, y(\theta), \tilde{z}) \theta dF \right] - \frac{dS}{dz} = 0$$

$$\int_{\theta}^{\hat{\theta}} \left[ l_y(x, y(\theta), \tilde{z}) \frac{\partial y}{\partial z} + l_z(x, y(\theta), \tilde{z}) \right] \theta dF + \frac{dS}{dz} = 0$$

we ultimately arrive at the condition

$$\alpha \left[ 1 + \int_{\theta}^{\hat{\theta}} l_z(x, y(\theta), \tilde{z}) \theta dF \right] = - \int_{\theta}^{\hat{\theta}} \left[ l_y(x, y(\theta), \tilde{z}) \frac{\partial y}{\partial z} + l_z(x, y(\theta), \tilde{z}) \right] \theta dF \tag{26}$$

Condition (26) differs from (24) in the strategic effect of a change in public safety for the level of injurer costs. The left-hand side represents the marginal cost to the public agent in terms of the implied change in the weighed social costs. The right-hand side represents the marginal benefit to the injurer from a marginal change in $z$. The key difference to the previous section arises from the fact that the injurer anticipates having to compensate expected harm. This leads the injurer to take into account the strategic effect of public safety on victims’ precautions, i.e., to value increases in public safety when it influences victim care.
in a way that lowers expected harm. Moreover, the direct influence of public safety with regard to the level of expected harm is of importance. Our main findings follow from the condition determining public safety, \( (26) \), and are summarized in the proposition below.

**Proposition 4** Assume that strict liability with a defense of contributory negligence applies. The level of public safety determined in a political equilibrium with lobbying by the injurer will be (i) above its efficient level when \( \frac{dy}{dz} > 0 \), (ii) higher or lower than its efficient level when \( \frac{dy}{dz} < 0 \) since the injurer values the direct marginal effect of public safety, while externalizing the marginal costs of it.

Under strict liability with a defense of contributory negligence with a due-care standard set at the efficient level, victims will obey the standard of care and thereby shift expected harm to injurers. As a result, benefits from public safety from the firm’s standpoint may arise via its influence on the level of expected harm and its impact on victim care-taking. Given that the injurer’s objective function lacks the costs of public safety and victim precaution, the firm’s influence on the public agent introduces a distortion away from the first-best outcome.

5 Discussion and conclusion

Liability rules are an important instrument to induce care-taking by private parties. Under standard assumptions, both negligence and strict liability with a defense of contributory negligence are capable of inducing socially optimal levels of private precaution and the first-best level of social costs. However, in many (if not most) circumstances, the level of expected harm is also influenced by regulations enacted by public agents. This paper shows that liability rules induce very different equilibria (implying very different levels of social costs) when the public agent chooses the regulation either to satisfy the needs of the median-voter victim or to accommodate the preferences of the lobbying injurer. Even though the liability rules are still comparable, in that the private precautionary investments will be socially optimal given the regulatory background, this equivalence by no means transfers to
the endogenous level of regulation or to the level of social costs in equilibrium. When it is realistic to assume that the context in which liability rules operate is indeed influenced by political economy aspects, then the decision for one liability rule over the other should also be based on the incentives of the respective parties to influence policy-makers. This follows from the fact that some parties will have an interest in public safety investment that is more closely aligned with that of society.

This study presents a first in-depth exploration of political economy issues in the realm of the economic analysis of liability law. To this end, the paper has used assumptions that show the repercussions of the political dimension most clearly. In our framework, we abstract from the possibility of holding public agents liable, and instead focus on objectives for the public agent that are standard in the political economy literature (e.g., being elected in the median-voter setup). In addition, our results build on having injurers and victims as distinct groups with conflicting interests. For example, the median-voter victim’s choice of public safety investments under negligence is higher when this increases the care-taking of the injurer (i.e., shifts some care costs to the injurer). There are circumstances in which this conflict of interest is more moderated. For example, in car accident settings, there may be role-type uncertainty such that private parties expect to be either injurer or victim with positive probability (e.g., Friehe 2007). Similarly, in product liability setups with perfect competition between firms, consumers as potential victims will ultimately pay the injurer’s cost of care. In summary, we may expect that our results will be moderated when the demarcation line between parties is less pronounced, which yields an empirically testable implication. There are other potential avenues for future research. For instance, it may be argued that the choice of the liability rule could also be described as subject to related political economy influences, and that the role of insurance in the interaction of public safety and private precautions may be worthy of exploration.
References


Appendix

Convexity of expected harm

By convexity, the following set of conditions is satisfied:

\[
\begin{align*}
& l_{yy} > 0 \\
& \begin{vmatrix} l_{xx} & l_{xy} \\ l_{xy} & l_{yy} \end{vmatrix} > 0 \\
& l_{zz} \begin{vmatrix} l_{xx} & l_{xy} \\ l_{xy} & l_{yz} \end{vmatrix} - l_{yz} \begin{vmatrix} l_{xx} & l_{xy} \\ l_{xy} & l_{yz} \end{vmatrix} + l_{zz} \begin{vmatrix} l_{xx} & l_{xy} \\ l_{xy} & l_{yy} \end{vmatrix} > 0
\end{align*}
\]

The second line can also be written as \( l_{xx}l_{yy} - l_{xy}^2 > 0 \).
Proof of Lemma 2

Claim (1) follows straightforwardly from (9) and (10). Claim (2) follows from the fact that \( \text{sign} \frac{dx}{dz} = \text{sign} \frac{\partial y}{\partial z} = \text{sign}(-l_{yz}) \) when the direct effect of a change in \( z \) dominates in (9) and (10). Regarding claim (3), note that when the indirect effect of a change in \( z \) dominates, then \( \text{sign} \frac{dx}{dz} = \text{sign}(l_{xy}l_{yz}) \) and \( \text{sign} \frac{\partial y}{\partial z} = \text{sign}(-\frac{dx}{dz}l_{xy}) \). As a result, we find that \( \frac{dx}{dz} > 0 \) when \( l_{xy} > 0 \) and \( l_{yz} > 0 \), whereas \( \frac{dy}{dz} < 0 \) under these conditions, and vice versa.

Proof of Lemma 3

In the following analysis, we rely on the results established in Lemma 2. When \( l_{xy} \leq 0 \), the first term in the brackets in (14) is either equal to zero or is of the same sign as the second term. When (14) is positive, this indicates that a marginal increase in public safety investment increases private costs for the considered victim type, such that this creates a demand for less investment. This establishes claim (1). When \( l_{xy} > 0 \) and the direct effect dominates in determining \( dx/dz \), the first term in the brackets in (14) is always of the opposite sign when compared to the sign of the second term. As a result, results require a ranking of influences as explicitly set out in claim (2). With regard to claim (3), when \( l_{xy} > 0 \) and the indirect effect of \( z \) dominates, we find that \( \text{sign} \frac{dx}{dz} = \text{sign}(l_{yz}) \). Thus, when \( l_{xy} > 0 \), the first term in the brackets in (14) is either equal to zero or is of the same sign as the second term \( l_{yz} \). When \( l_{xy} > 0 \) and the indirect effect dominates in determining \( dx/dz \), the first term and thus the sum in the bracket also have the same sign as the second term \( l_{yz} \).

Proof of Lemma 4

For a given level of public safety investment, the Nash equilibrium in the second stage is such that each party selects a care level that is socially optimal for the given level of public safety. Each victim \( \theta \) chooses to obey the due-care standard \( y_s(\theta) = y(\theta, z) \) which satisfies (4) for a given \( z \). At the same time, the injurer chooses \( x(z) = \arg \min_x \left[ x + \int_\theta \frac{\partial}{\partial x} l(x, y(\theta), z) \theta dF(\theta) \right] \), which satisfies the condition equivalent to (2) for a given \( z \).
Proof of Lemma 5

Let us consider condition (18) and evaluate:

\[
\frac{\partial^2 VC^{SLCN}}{\partial z \partial \theta_m} = \frac{\partial^2 y(z, \theta_m)}{\partial z \partial \theta_m} + \frac{1}{E}.
\]

Under the assumption that third derivatives are negligible in magnitude, we find that the marginal benefit for public safety is not critically influenced by the income level of the victim. In contrast, the level of marginal costs is increasing with the income level of the victim. This qualification weakly ensures that the lemma also covers the case in which \( \partial y/\partial z > 0 \), such that all victims prefer no public safety.