On the optimal scope of negligence

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On The Optimal Scope of Negligence

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This article studies the optimal scope of negligence, considering which of the parties' precautionary measures should be included in the determination of negligence and which instead should be omitted. The analysis shows that the optimal scope of negligence balances the gains derived from improved accident prevention with the administrative costs of the system. This approach also provides insights concerning not only the notions of care and activity level and their respective boundaries, but also the choice between strict liability and negligence.

Stat rosa pristina nomine, nomina nuda tenemus[**]

1. INTRODUCTION

Thus far, economic analysis of tort liability has focused on the problem of defining optimal *levels* of due care, such as the maximum speed on the road. However, both reality and the law are more complex than that. In fact,

[**] "The primordial rose still exists through its name; it is naked names we cling to." As quoted in Umberto Eco (1980, *Il nome della rosa*, Milano: Bompiani; English version, 1983, *The Name of the Rose*, San Diego: Harcourt) from Bernard of Morlay, *De contemptu mundi*.

motorists can prevent accidents not only by moderating their speed, but also by maintaining well-functioning brakes, correctly using the rear-view mirror, avoiding driving when tired, driving their car less often, and so forth. Interestingly, only some of these precautionary measures are relevant for a finding of negligence.

Under any fault-based liability rule, the law or the courts determine due *levels* of precautions, and define the *scope* of negligence, determining which of all possible precautionary measures enter into the negligence inquiry. Until now, economic analyses have disregarded the multidimensional nature of precaution and thus have not studied the optimal composition of the bundle of precautionary measures that, if not taken, amount to negligent behavior.[1]

To use a metaphor, the set of precautions may be analogized to a school of fish. When one employs a fishing net (the negligence criterion) some fish will be caught (precautions included in the negligence inquiry) while some will swim away (precautions omitted from the negligence inquiry). This article is concerned with the optimal size of the fishing net (the optimal scope of negligence), which balances the (administrative) cost of having a bigger net with the benefit of catching more fish (improved incentives to take precaution).

I will also demonstrate that setting the scope of negligence is conceptually equivalent to defining the boundary between the notions of care and activity level, the two most fundamental concepts in the economic analysis of tort liability. According to the initial definitions given by Shavell (1980a), these notions exclusively depend on the determination of negligence, that is, they are *endogenous* to the legal system.[2] "Care" simply denotes those precautionary

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[1] My endeavor is close in spirit to Demsetz (1967), who lamented that economists had only taken into account the price and quantity of goods exchanged in the marketplace, while disregarding how the bundle of rights that is exchanged with the goods (or that constitutes the goods) is formed.

[2] See Shavell (1980a:2-9, 22, 23), maintaining that "it can be seen that what is important about the variable 'activity level' is only that it is not included in the care standard." See also Shavell (1987:9, 25, 36-remark 2, 40-remark 2, 46-text and fn 59), noting that the *only* crucial divide between care and activity level is the fact that negligence rules incorporate care, but do not incorporate activity level. Critics of this approach have only partially accepted that the concepts of care and activity level are endogenous in nature: see Donohue (1989:1062), Latin (1987:503), and Gilles (1992:329). See instead Miceli (1997:28), and Kaplow and Shavell (2002), on correctly distinguishing care from activity level on the basis of the negligence inquiry. In accordance with this approach, Grady (1988) argues that accidents resulting from the lack of some precautionary measures (referred to as nondurable precautions) are treated under strict liability, that is, such precautionary measures are omitted from the determination of negligence and trigger liability *per se*. At 306-307, the author remarks that this happens because "[g]enerally, it may be too costly for them to acquire information about the actor's rate of compliance to see whether it was

measures for which a duty of care has been established (that is, they are included in the negligence criterion); on the other hand, "activity level" refers to other precautionary measures for which a duty of care has not been established (that is, they are omitted from the negligence inquiry).

Nevertheless, all formal models of tort law have adopted simpler *exogenous* concepts (apparently determined according to some natural and immutable criteria, other than the law), thus completely missing the opportunity to discuss the issues under scrutiny here. The exogenous approach, although very successful on pedagogical grounds,[3] will be shown to be theoretically incorrect and logically inconsistent, besides obfuscating the real endogenous nature of these concepts and the problem of setting the scope of negligence.[4]

In section 2, I will inspect why this additional dimension of the negligence inquiry has been neglected in previous economic analyses. This is due, as I will explain, to a didactic use of the exogenous versions of the concepts of care and activity level. In sections 3 through 5, I will provide a model for the optimal *scope* of negligence and, in section 6, I will show how recognizing the importance of this problem changes our understanding both of the choice between strict liability and negligence, and of the related question of who should bear the residual cost of accidents. Section 7 will conclude.

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reasonable" (see also the passage at 309 dealing with activity level). By so doing, "they effectively create a pocket of strict liability at the heart of the negligence rule." See the related discussion in section 6.1.

[3] Miceli (1997:27), defines activity level as "how frequently or intensively to engage in a risky activity," and writes, "For example, the driver of an automobile decides how carefully to drive, but also how often and how many miles." See also Miceli (2004:66), Landes and Posner (1981:851, 875-878), and (1987:61), and Posner (2003:178), remarking that "one way to avoid an auto accident is to drive more slowly; another is to drive less," all adopt the same definitions. Cooter and Ulen (2003:332), define activity level as the "amount" of one's action, while the definition of care is generally a straightforward identification with the common concept of precaution. See also Brown (1998:18). The same approach can be found in Epstein (1999:97).

[4] This study also relates to the literature on how accurate legal rules should be. See Kaplow and Shavell (1994), discussing mistakes in determining who committed a harmful act, Kaplow and Shavell (1996), studying accuracy in the assessment of damages, Craswell and Calfee (1986), discussing the effect of uncertainty in determining the *level* of due care, and Ganuza and Gomez (2005), discussing the tailoring of the injurer's *level* of due care to heterogeneous victims' types. See also Kaplow (1995), discussing in general the optimal degree of complexity of legal rules. To my knowledge, issues concerning the *scope* of negligence have not been discussed in this literature. The present study also relates to the relatively few studies examining precaution as a multidimensional variable. An example is Trebilcock and Winter (1997:225-227), discussing the combination of regulation and strict liability used when regulators can only observe some precautionary measures. This literature, however, does not investigate the determination of negligence.

2. THE BOUNDARY BETWEEN CARE AND ACTIVITY LEVEL

The distinction between the concepts of care and activity level is fundamental for the law and economics of tort liability. It was emphasized in the early economic analyses of tort liability,[5] and later brought to its state-of-the-art conceptualization by Shavell (1980a).

Shavell asked the question why some precautionary measures – such as the frequency with which motorists use their cars, or the correct use of the rear-view mirror – are not always incorporated into the determination of negligence, although they are relevant for accident prevention. He found that the reason is the excessive cost of observing these precautionary measures and calculating their optimal levels.[6]

Stated differently, the complete set $P = \{p_1, ..., p_z\}$ of all possible precautionary measures may be ideally subdivided into two subsets: *care*, the subset C of those measures that are included in the determination of

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[5] See Calabresi (1970:108-109, 259-261). Posner (1973:208-209) noted that precautionary measures not taken into account by the courts in determining negligence will only be taken by the residual bearer. He describes the choice between railroad and canal transportation, and notes that even when both are carried out with optimal care there will nevertheless be a certain number of unavoidable accidents. He assumes that the frequency of unavoidable accidents is higher for the railroad. Hence some of those accidents "are not unavoidable. In fact, they could be avoided by the substitution of canal for railroad transportation." He further notes that "in principle a negligence standard would require the railroad to bear the cost of those accidents […] But perhaps courts are incapable of making interindustry comparisons in applying the negligence standard." The latter remark is in line with my contention that the divide between different classes of precautionary measures is based on whether or not they are verified before the court. Diamond (1974a:146) distinguishes between three different sets of precautionary measures: 1) (a reduction in) the time devoted to the activity, 2) precaution that affects the magnitude of the harm, and 3) precaution that affects the probability of an accident. In the analysis, he assumes that courts do not consider the former two and only base their judgment on the latter. Other than some differences in the formalization of the problem and in the terminology used, such conceptualizations are substantially endogenous.

[6] See also Shavell (1987:25, 50, 56, 57), Landes and Posner (1987:66-67), and Miceli (1997:28). There is, nevertheless, an internal inconsistency in Shavell's own literature. In fact, if one accepts the endogenous definitions, one must also concede that if no negligence inquiry applies, the distinction between care and activity level simply does not exist. Thus, under strict liability, the subsets themselves cannot be defined for lack of a criterion to do so, because (since precaution does not enter into the negligence inquiry) all of the parties' precautionary measures have to be defined as activity level. Shavell (1980b:476), analyzing the issue of causation, states that in order to understand how the scope of liability should be determined "we must consider the effect of strict liability on the injurer's decision whether to engage in an activity and, if so, on his decision about care." Shavell's subsequent analysis is based on such a distinction. The problem is how to define the concepts of care and activity level in this case, since no negligence inquiry applies.

negligence, and *activity level*, the residual subset A of those measures that are omitted from it.

Accordingly, whether a specific precautionary measure p_i belongs to the subset C or to the subset A depends solely on whether or not a duty of care has been established, and thus it is a mere matter of law. In this sense, the notions of care and activity level are entirely *endogenous* to the legal system and, more precisely, to the determination of negligence.[7]

It is easy to see that, according to these definitions, care and activity levels are complementary subsets of P, $C \cup A = P$, and that their intersection is empty, $C \cap A = \{\varnothing\}$. In other words, a precautionary measure p_i belongs either to C or to A, that is, any precautionary measure is either to be defined as care or as activity level, *tertium non datur*.

Furthermore, since care is precisely what enters the negligence inquiry, the scope of negligence and the definition of care are identical notions and, if the determination of negligence changes, the definition of care and the subsequent complementary definition of activity level will also change.[8]

Although it is clear from Shavell's analysis that the notions of care and activity level are endogenous to the legal system, in order to illustrate these concepts, Shavell refers to care as the precaution used while engaged in a certain activity, and he refers to activity level as the frequency of such an activity.[9] These pedagogical simplifications are substantially different from the original definitions, as they depict care and activity level as exogenous concepts, defined on the basis of some natural characteristics, which are independent of the law.

These simplified exogenous definitions have been more successful than the original endogenous ones, and have pervaded law and economics textbooks[10]

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[7] See fn 2 above.

[8] Shavell (1980a:11, 22-23,) and (1987:26, 46) acknowledges that the negligence criterion could in theory encompass all of the parties' precautionary measures; in this case, the negligence rule would provide optimal incentives with respect to all of them, and the subset A would be empty. See also Calabresi (1970:111).

[9] Shavell (1987:5), provides the following definition: "The number of miles an individual drives, for instance, might be interpreted as his level of activity, and the precaution he takes when on the road (slowing for curves, paying attention to the presence of bicyclists) as his level of care. Similarly, how often a bicyclist rides where there is automobile traffic might be regarded as his level of activity, and his precaution when riding (staying close to the side of the road, using a brightly colored vest) as his level of care." Consider also the prose of Shavell (1980a:2 ff).

[10] See fn 3 above for a review of the literature.

and the mathematical models written so far.[11] It is clear that moving from endogenous to exogenous notions veils issues concerning the optimal scope of negligence. Moreover, the exogenous definitions are only valid as examples. On both the theoretical and the empirical level, they are incorrect and logically inconsistent. Thus, they should be used with caution.

The exogenous definitions are incorrect because they imply that the repetition of any risky activity necessarily escapes the negligence inquiry; on the contrary, this is true only for some activities and not for others. Gilles (1992) finds that American courts often consider such issues under negligence.[12] Likewise, as Grady (1988, 1994) notes, it is not always the case that the way in which a dangerous activity is conducted is considered while determining negligence; there are in fact many precautionary measures that have nothing to do with the repetition of risky actions which nevertheless are omitted from the negligence inquiry.[13] Shavell (1987:9) refers, for example, to the use of the rear-view mirror as a typical precautionary measure that is not taken into account while deciding on a motorist's negligence.[14] The exogenous definitions are thus both over-inclusive and under-inclusive, and they fall short of both proper conceptualization and actual judicial practice.

They are also logically inconsistent, because they are not mutually exclusive. In other words, any precautionary measure defined as care according to the exogenous definitions can be reinterpreted as a level of activity and vice versa.[15] For example, riding a bike on a dangerous road may be seen as a lack of care, if emphasis is put on the fact that the cyclist could have ridden on a safer trail. However, one could interpret this form of precaution as the

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[11] The standard model derives from Shavell (1980a), who models care as a one-dimensional variable x for the injurer or y for the victim. Likewise, activity level is modeled as a one-dimensional variable s for the injurer or t for the victim. Neither this mathematical formulation nor those that followed addressed the problem of choosing which precautionary measures to put in x and which to put in s.

[12] See also Shavell (1987:9, 26-text and fn 33), and Landes and Posner (1987:70-71).

[13] Grady (1988, 1994) argues that inadvertent negligence (also called compliance error) is sometimes efficient and thus should not trigger a finding of negligence. Nevertheless, due to the excessive cost of verifying nondurable precautions before the courts, such lapses generally trigger liability, thus opening pockets of strict liability within the negligence rule or inverting the burden of proof. See also fn 2 above.

[14] Shavell (1980a:23), making the point that not only the frequency of an activity escapes the determination of negligence, notes that "Any other variable omitted from the standard would also be inappropriately chosen in many of the circumstances in which we said the same of the level of activity." See also Shavell (1980a:10, fn 14) and (1987:9), where he speaks of several dimensions of care.

[15] See Gilles (1992:329-336) recognizing this point.

frequency of the activity "riding on dangerous paths," which is a different activity from "riding on safe paths."[16] This exercise can be easily repeated for any other precautionary measure: speed may be seen as care or, alternatively, driving fast may be seen as a different activity from driving slowly; taking one's car less often and switching to public transportation may be seen as care or, alternatively, mileage may be seen as a level of activity; and so forth.[17]

Is the number of trains running between two cities to be considered an activity level, or is the appropriate reduction of the train traffic on a specific track to be regarded as care? This and similar questions cannot be unambiguously answered within the exogenous approach, while they have an unequivocal solution in the endogenous one. A precautionary measure is defined as care if the court considers this aspect while deciding on the issue of negligence, while it is considered an activity level otherwise.

Other distinctions are often proposed in the literature, such as frequency claims versus choice-of-activity claims, avoidable versus unavoidable accidents, and similar categorizations. These notions are exogenous since they refer to some intrinsic characteristics of precaution independent of the law, as we have demonstrated.

In most studies,[18] these notions obscure the basic question of why the courts establish a duty of care only for some precautionary measures and not for others. The reason might be that the courts suffer from some a priori bias against, say, frequency claims, but a better explanation is that bringing frequency claims into the determination of negligence would often entail prohibitively high administrative costs (acquisition of information, determination of causation, and so forth). Thus, it is crucial to assess the

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[16] Diamond (1974:110) observes that "The distinction [between care and activity level] is somewhat artificial in that we could define negligent driving as a different activity from non-negligent driving." Nevertheless, Diamond adopts slightly different concepts of care and activity level from those adopted by Shavell (1980a).

[17] Terry (1915) quotes the case of a man, who, after taking every (other) possible precaution, went upon the tracks to save a child but was killed by an oncoming train. The jury found him not guilty of contributory negligence (*Eckert vs. Long Island R. R. Co., 43 N.Y., 1871*). An opposite decision would have been taken were the creature a kitten (Terry, 1915:43-44). See also Posner (2003:169-170). Not attempting a rescue is indeed a form of precaution, at the cost of a life's value. Going upon the tracks is hence considered in the negligence inquiry, although at first sight we would say that it is an activity level. Gilles (1992) constructs a strong argument on this point and gives many examples. He shows that "the courts should be able to regulate many activity-level choices by developing rules concerning reasonableness or unreasonableness of particular activities as well as their timing, place and scope" and indeed "modern American negligence law regulates activity levels to a considerably greater scope than has previously been recognized" (Gilles, 1992:320). See also Grady (1983).

[18] See Gilles (1992:327) for a critical account of different views.

administrative costs of evaluating the parties' behavior, rather than referring to the nature of their precautionary measures.

In other contributions (as in Grady, 1988, 1994, and 1998), notions of durable versus nondurable precautions are employed to distinguish between those precautionary measures that are easily verified before the court and those that are not. The present study is situated in this line of research and tries to bring the argument forward by disposing of these exogenous proxies and focusing on the endogenous nature of the problem of determining the scope of negligence.

3. A MODEL OF THE OPTIMAL *SCOPE* OF NEGLIGENCE

We consider accidents between a victim and an injurer, strangers to each other, both rational and risk neutral. The parties minimize the sum of precaution costs and expected accident loss that each bears under a given liability regime. The victim is the party that suffers harm; the injurer is the other party. Causation is assumed to be satisfactorily established. Contrary to the standard model, parties' precaution is multidimensional: both parties can reduce the expected accident loss by taking many different precautionary measures.

In vectors, subscripts denote the position of the element in the vector; in functions, subscripts denote partial derivatives. When applicable, functions will be assumed to be continuous and continuously differentiable to any desired order. In order to simplify notation we will use standard letters for the injurer and the same letters with an upper bar for the victim. Assumptions and notations will only be stated for the injurer, but will automatically apply to the victim as well. For example, p_i will denote one of the injurer's precautionary measures; hence, $\bar{p}_{\bar{i}}$ will denote one of the victim's precautionary measures. Let:

P = row vector of all the injurer's possible precautionary measures, $\underset{1\times z}{P} = [p_i]$, $p_i \geq 0$, $i = 1,\dots,z$;

l = expected accident loss, $l = l(p_1,\dots,p_z,\bar{p}_1,\dots,\bar{p}_{\bar{z}})$ is a decreasing and strictly convex function of each of the parties' precautionary measures.

Let the social objective be the minimization of the sum of expected accident loss and the parties' precautions:

(1) $\quad \min_{p_i, \bar{p}_i} \left[l\left(p_1, \ldots, p_z, \bar{p}_1, \ldots, \bar{p}_{\bar{z}}\right) + p_1 + \ldots + p_z + \bar{p}_1 + \ldots + \bar{p}_{\bar{z}} \right]$

From the assumptions made, it follows that there will be unique optimal levels $p_i{}^*$ and $\bar{p}_i^*$ of each of the parties' precautionary measures that minimize Exp. (1). We will now rewrite this model in an equivalent yet simpler way. Let us separate the parties' choice over precaution into two distinct steps: the decision of whether or not to take a precautionary measure, and, if so, the choice of the appropriate level. The latter choice will still be expressed by the vector P. With regard to the former, let:

E = column vector of the injurer's choice of whether or not to take a precautionary measure, $\underset{z \times 1}{E} = \left[e_i \right]$, $e_i \in \{0,1\}$, $i=1,\ldots,z$;

if $e_i = 0$, then $p_i = 0$; if $e_i = 1$, then $p_i \geq 0$.

The column vector E describes the choice of whether or not to take a certain precautionary measure out of the row vector P; e_i equals 1 if precaution p_i is taken and 0 if it is not. The vector E is a redundant element: it is easy to show that $e_i p_i = p_i$.[19] Therefore, the social objective may be rewritten in the following way, which is equivalent to Exp. (1).

(2) $\quad \min_{p_i, e_i, \bar{p}_i, \bar{e}_i} \left[l\left(e_1 p_1, \ldots, e_z p_z, \bar{e}_1 \bar{p}_1, \ldots, \bar{e}_{\bar{z}} \bar{p}_{\bar{z}}\right) + e_1 p_1 + \ldots + e_z p_z + \bar{e}_1 \bar{p}_1 + \ldots + \bar{e}_{\bar{z}} \bar{p}_{\bar{z}} \right]$

Let us now simplify Exp. (2). The injurer's total expenditure in precaution and the number of the injurer's precautionary measures can be denoted by scalars as follows. Let:

x = *level* of precaution, the injurer's total expenditure in precaution, $x = PE$.

n = *scope* of precaution, the number of precautionary measures that the injurer takes, $n = E^T E$.

Note that x is simply the sum of each taken p_i. Since the order of the precautionary measures is arbitrarily given, we can assume without loss of generality that the elements in the vectors P and E are always ordered so that $e_i = 1$ for $i = 1, \ldots, n$ and $e_i = 0$ for $i = n+1, \ldots, z$. In other words, the taken precautionary measures are listed before the measures not taken.

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[19] In fact, a positive level of p_i implies $e_i = 1$, hence $p_i e_i = p_i$. If $p_i = 0$, $p_i e_i = 0 = p_i$ for any value of e_i.

In addition, from the assumption of rational and wealth maximizing parties, it follows that:

> (I) Each party allocates optimally his precautionary expenditure x among the n precautionary measures that he takes, so that the expected accident loss cannot be further reduced without increasing x or n.[20]

Given a pair (x, n), the individual level of each precautionary measure can be regarded as automatically determined according to assumption (I). It follows that each pair (x, n) uniquely[21] determines a certain level of the expected accident loss, which results from the optimal allocation of the expenditure x among the n precautionary measures taken. Given optimal internal allocation of x, the problem of determining the optimal level of each p_i is transformed into the problem of determining the optimal x. Thus, the expected accident loss of Exp. (1) can be redefined as follows. Let:

$$l \quad = \quad \text{expected accident loss, } l = l\left(x, n, \overline{x}, \overline{n}\right).$$

The expected accident loss depends on *how much* parties spend on precaution (the level x) and on *how many* precautionary measures they take (the scope n). For example, $l\,(10,3,25,2)$ indicates the expected accident loss when the injurer spends a total of 10 on precautionary measures p_1, p_2, and p_3, and the victim spends 25 on precautionary measures $\overline{p}_1$ and $\overline{p}_2$.

From the assumption that l is a decreasing and strictly convex function of p_i, it follows that l is also a decreasing and strictly convex function of x for any given n;[22] hence, the expected accident loss decreases (at a decreasing rate) if parties' precaution expenditures increase. Moreover, given assumption (I), it follows that when the number n of taken precautionary measures increases, the expected accident loss decreases or remains constant, because any additional precautionary measure can always be taken at a level equal to zero if it worsens accident prevention. Adding precautionary measures is equivalent to

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[20] Assumption (I) is equivalent to saying that the taken levels of $p_1,…, p_n$ are those levels that minimize l subject to $p_1+…+p_n=x$, which directly follows from the assumptions of rationality and wealth maximization.

[21] It can be noted that any pair (x, n) yields a unique level of l, which is the lowest level of l attainable by allocating x among the n precautionary measures.

[22] Note that, as x is defined as the sum of all p_i, a variation in one p_i, all others being constant, yields an equal variation in x. Therefore, the assumption that l is strictly convex in each p_i, which is the extension to the multidimensional case of the assumption usually made in the standard model, yields that l is strictly convex in x, as we assume.

broadening accident prevention, while preserving the option not to invest in them. To summarize, from the assumptions of the standard model regarding the shape of l, we can derive two properties:

(II) l is a decreasing and strictly convex function of x, with $l_x<0$ and $l_{xx}>0$.

(III) $\left(\dfrac{\Delta l}{\Delta n}\right)_{x=\text{constant}} \leq 0$.

This section should have convinced the reader that the standard model may be extended to encompass the possibility that parties may take various precautionary measures without adding assumptions or altering its substance, and that such an expanded model may be rewritten in a simpler way without loss of generality. Instead of focusing on each single precautionary measure, this expanded model focuses on two macro-elements: the *scope* of precaution (the number of taken precautionary measures), and the *level* of precaution (the parties' total expenditure on precaution).

4. THE MODEL WITHOUT ADMINISTRATIVE COSTS

We start with the analysis of an ideal world, in which the liability system functions without administrative costs. We will later introduce administrative costs into the framework. This way we will be able to appreciate that the need to distinguish between care and activity level only arises when administrative costs limit the optimal scope of the negligence criterion, rendering it necessary to omit some of the parties' precautionary measures from the negligence inquiry. The issue of parties' compliance with the negligence standards is addressed in the appendix.

4.1. SOCIAL COSTS IN A WORLD WITHOUT ADMINISTRATIVE COSTS

If the liability system functions without administrative costs, we simply define the social objective again as the minimization of the expected accident loss and the parties' expenditures in precaution.

(3) $\min\limits_{x,n,\overline{x},\overline{n}}\left[l\left(x,n,\overline{x},\overline{n}\right)+x+\overline{x}\right]$ or $\min\limits_{x,\overline{x}}\left[l\left(x,\underline{z},\overline{x},\overline{z}\right)+x+\overline{x}\right]$.

Let an asterisk mark the optimal values. Given assumption (III), $n^*=\underline{z}$. Thus, the second part of Exp. (3) is correct. Moreover, given assumption (II), the solution is given by (unique) levels of precaution x^* and $\overline{x}^*$ of the injurer and

the victim, respectively, that solve $l_x+1=0$ and $l_{\bar{x}}+1=0$. The result we just obtained can be interpreted as follows: when there is no administrative cost, the social cost is minimized when parties take optimal levels of precaution expenditures and allocate them optimally among all their precautionary measures.

4.2. LIABILITY RULES IN A WORLD WITHOUT ADMINISTRATIVE COSTS

In this section, we consider four possible rules and compare their outcomes with the social objective defined above: two strict rules (strict liability and no liability) and two negligence rules (strict liability with defense of contributory negligence,[23] which is a strict-liability-based negligence rule, and simple negligence,[24] which is a no-liability-based negligence rule).[25]

  The legal system makes two choices: it chooses the residual bearer, and it decides whether and with what scope a negligence inquiry should apply. With regard to the negligence inquiry, unlike in the standard model, it ought to be specified *which* precautionary measures the party has to take (the *scope* of the negligence criterion) and the due care *level* of each of them.

4.2.1. Setting the negligence criterion when the victim is the residual bearer (negligence applies to the injurer)

The no liability rule and simple negligence may be seen in continuity with each other: no liability is a simple negligence rule where the scope of the negligence criterion is zero, whereas under simple negligence, the criterion encompasses some injurer's precautionary measures, and sets the due level for each of them. The victim is not subject to a negligence inquiry. Let us define the negligence criterion as determining the level of each of the precautionary measures that the injurer ought to take. The superscript ^{d} stands for "due level." It is worthwhile to note that, while in the standard model the negligence criterion is defined as the due level of care, in this model--since precaution is

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[23] Under strict liability with a defense of contributory negligence, the injurer pays damages to the victim unless the victim is found negligent.

[24] Under simple negligence, the victim bears the accident loss unless the injurer is found negligent, in which case he pays damages to the victim. Although contributory negligence and comparative negligence also subject the victim's behavior to a negligence inquiry, the victim is the residual bearer and he will thus take precaution with respect to all his precautionary measures (as shown by Shavell, 1980a). As a result, there is no difference with respect to simple negligence. Only with respect to injurers does a distinction between activity level and care have a meaning. The same can be said with respect to the victim under negligence rules based on strict liability.

[25] In this classification, I follow Brown (1973).

multidimensional in nature--the negligence criterion must also be multidimensional:[26]

(4) $\underset{1 \times n}{N} = [p_i^d]$.

It is reasonable to assume that:

> (IV) For any given n and x, the social planner allocates the precaution expenditure x among the n precautionary measures included in the negligence criterion such that the expected accident loss cannot be further reduced without increasing x or n.

As we have done above, the negligence criterion of Exp. (4) can be redefined as a pair of x and n:[27]

(5) $N = (x, n)$.

The problem of optimally setting the negligence criterion is therefore reduced to a two-fold problem: the determination of the *optimal scope n* and of the *optimal level x*. Again, no liability is a rule in which $n=0$, while simple negligence has $n>0$.

As in the standard model, if the negligence criterion is set at the socially optimal *level* and *scope*, both parties will take the socially optimal precautions in equilibrium (see section A in the appendix). Thus, the optimal scope and the optimal level of the negligence criterion are x^* and $n^*=z$. As a result, the optimal no-liability-based rule is an omni-comprehensive simple negligence rule, under which all of the injurer's precautionary measures are verified before the court while deciding the issue of negligence.

4.2.2. Setting the negligence criterion when the injurer is the residual bearer (negligence applies to the victim)

For the sake of completeness, the same exercise can be repeated for strict liability. The residual bearer is the injurer and the negligence criterion focuses

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[26] The negligence criterion targets some specific actions on the part of the injurer. In theory, the court could verify directly the expenditure x, instead of verifying the injurer's behavior as regards many different precautionary measures. However, the cost of precaution is often non-monetary and, although it can sometimes be estimated, it is very difficult to verify. When it is possible to verify the costs directly, the problem becomes easier to solve.

[27] The ordering of the precautionary measures is relevant at this point. However, since it is merely arbitrary, it can always be adjusted so as to be consistent with the results of the analysis.

on the victim's behavior, and may thus be described as $\overline{N} = (\overline{x}, \overline{n})$. Likewise, the optimal scope will be $\overline{n}* = \overline{\chi}$ and the optimal level $\overline{x}*$. The optimal strict-liability-based rule encompasses a negligence defense, under which all of the victim's precautionary measures are taken into account.

4.2.3. Choosing the residual bearer when there are no administrative costs

From the former analysis emerges the notion that both simple negligence and strict liability with a defense of contributory negligence achieve the social optimum, as they both induce the victim and the injurer to take the optimal level in all of their precautionary measures. Whether the injurer or the victim is the residual bearer is irrelevant for the efficiency of the rule.

5. THE MODEL WITH ADMINISTRATIVE COSTS

In this section, we will introduce administrative costs in the functioning of liability.[28] These costs encompass both the costs directly borne by the parties and the costs to the courts ultimately borne by taxpayers.[29] We will consider two types of administrative costs: information costs and compensation costs.[30]

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[28] The literature has mainly been concerned with two problems: first, the effect of litigation costs on the levels of precaution actually taken by the parties (see Shavell (1987:ch. 11), Polinsky and Rubinfeld (1988a, 1988b), Hylton (1990), Miceli and Segerson (1991), Polinsky and Che (1991), Kahan and Tuckman (1995), and Kaplow (1993)) and secondly, the desirability of liability when litigation is costly (see Shavell (1982), Menell (1983), Kaplow (1986), and Rose-Ackerman and Geistfeld (1987)). On these grounds the relative advantages of different liability rules have been compared, see Goldberg (1984), Shavell (1987:264) and Miceli (1997:44) for an assessment. The perspective taken in this study is different: I analyze the problem of how the liability rule should be designed in the first place in response to the presence of litigation costs. In particular, I examine the novel problem of how the optimal scope of negligence (and consequently its level) changes as a function of litigation costs. Subsequently, I employ my findings to inquire how the choice among different liability rules is affected by litigation costs. Moreover, while the literature has traditionally compared strict liability with simple (or comparative or contributory) negligence, my analysis is extended also to strict liability with a defense of negligence.

[29] For simplicity, however, we do not consider the effect of these costs on the plaintiff's decision of whether or not to sue.

[30] For simplicity we assume that the scope of negligence n cannot be influenced by the parties during the trial. That is, the parties can only attempt to prove or disprove negligence concerning the precautionary measures for which a duty of care is established, but cannot argue about whether or not a duty of care should be established. In other words, n does not depend on the parties' investments in litigation but, to the contrary, the parties' litigation costs depend on n.

Let:

$I(n)$ = information costs in the case of simple negligence and no liability;

$\bar{I}(\bar{n})$ = information costs in the case of strict liability with or without a defense of contributory negligence;

K = compensation costs in the case of strict liability with or without a negligence defense.

Information costs are the *variable* costs of establishing negligence. They may consist not only of the costs of gathering information needed to verify one party's behavior, but also of the costs due to a higher likelihood of errors and increased litigation, including the costs of judicial proceedings, lawyers' fees and any indirect costs borne by the parties.[31] Thus, let us assume:

(V) $\Delta I / \Delta n > 0$, $I(0) = 0$.

Compensation costs K are the *fixed* costs of transferring damage compensation from the injurer to the victim. In equilibrium, compensation costs arise only under strict-liability-based rules. In fact, under no-liability-based rules, the injurer's dominant strategy is to behave according to the negligence criterion, and he therefore never pays compensation.[32] Under strict-liability-based rules, the injurer always pays compensation to the victim, as the victim's dominant strategy is to behave non-negligently.

5.1. SOCIAL COSTS IN A WORLD WITH ADMINISTRATIVE COSTS

In a world with administrative costs, social costs encompass not only the cost of taking precaution and the expected accident loss as before, but also the administrative costs of the liability system. Depending on which party bears the residual loss, Exp (3) becomes:

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[31] The fact that parties may settle might reduce the magnitude of information costs, but does not eliminate the need for negligence criteria to be at least potentially verifiable before the court, and hence does not eliminate information costs; see Ordover (1978) and Hylton (1990) on this point. On the fact that the possibility of settlement does not eliminate the presence of litigation costs, as the parties will incur them during the settlement bargaining, see also Miceli (1997:39-44).

[32] In reality, some cases are litigated (and adjudicated) also under simple negligence. This point might bear on the magnitude of K. Negative values of K would depict a situation where, in equilibrium, more cases yield victims' compensation under simple negligence than under strict liability with a defense of contributory negligence.

(6) $\min\limits_{x,n,\overline{x},\overline{n}}\left[l(x,n,\overline{x},\overline{n})+x+\overline{x}+I(n)\right],$

for simple negligence and no liability (the victim is the residual bearer, the negligence inquiry targets the injurer), and

(7) $\min\limits_{x,n,\overline{x},\overline{n}}\left[l(x,n,\overline{x},\overline{n})+x+\overline{x}+\overline{I}(\overline{n})+K\right],$

for rules based on strict liability with or without a negligence defense (the injurer is the residual bearer, the negligence inquiry targets the victim). Let us begin the analysis from the former case, in which the victim is the residual bearer. For any n, Exp. (6) is minimized by $\overline{n}=\overline{\overline{z}}$ – which follows directly from assumption (III) – and by unique values of x and $\overline{x}$ that can be written as $x(n)$ and $\overline{x}(n)$. Furthermore, let:

> $L(n) =$ total accident costs in the case of simple negligence and no liability, where $L(n)=l\big(x(n),n,\overline{x}(n),\overline{\overline{z}}\big)+x(n)+\overline{x}(n)$.

Thus, Exp. (6) can be rewritten as:

(8) $\min\limits_{n}\left[L(n)+I(n)\right].$

Let n^{j} denote the level of n that solves Exp. (8): the optimal scope of the negligence rule balances decreasing accidents costs with increasing administrative costs; n^{j} may assume any value between 0 and $n^{*}=z$. If $n^{j}<z$, it is efficient to let the injurer not take some precautionary measures in order to save information costs. If $n^{j}=0$, no liability is superior to simple negligence, and it is thus efficient to let the injurer not take precautions. For the sake of completeness, let $x^{j}=x(n^{j})$ and $\overline{x}^{\,j}=\overline{x}(n^{j})$ denote the (unique) optimal *levels* of x and $\overline{x}$ when the victim is the residual bearer, which minimize Exp. (6).

Likewise, Exp. (7) can be rewritten as:

(9) $\min\limits_{\overline{n}}\left[\overline{L}(\overline{n})+\overline{I}(\overline{n})+K\right],$

where:

> $\overline{L}(\overline{n})=$ total accident cost in the case of strict-liability-based rules, where $\overline{L}(\overline{n})=l\big(x(\overline{n}),z,\overline{x}(\overline{n}),\overline{n}\big)+x(\overline{n})+\overline{x}(\overline{n})$

Let $0 \leq \bar{n}^{v} \leq \bar{z}$ denote the value of $\bar{n}$ that solves Exp. (9). Let x^{v} and $\bar{x}^{v}$ denote the (unique) optimal levels of x and $\bar{x}$ when the injurer is the residual bearer, which minimize Exp. (7).

We can now compare the results attained under the two separate hypotheses in order to ascertain whether it is socially efficient for the victim or the injurer to be the residual bearer. It is socially desirable to choose the setting that yields the least social costs, the criterion being:

(10) $\underbrace{L(n^{j}) + I(n^{j})}_{\substack{\text{the victim is the residual bearer} \\ \text{negligence applies to the injurer}}}$ <> $\underbrace{\bar{L}(\bar{n}^{v}) + \bar{I}(\bar{n}^{v}) + K}_{\substack{\text{the injurer is the residual bearer} \\ \text{negligence applies to the victim}}}$.

5.2. LIABILITY RULES IN A WORLD WITH ADMINISTRATIVE COSTS

Let us now analyze how different liability rules can be defined in order to achieve the social objective indicated in the previous section.

5.2.1. Setting the negligence criterion when the victim is the residual bearer (negligence applies to the injurer)

In a world without administrative costs, $n^* = z$ was optimal. If administrative costs are introduced, the scope of the negligence criterion might be optimally restricted to n^j in order to save information costs. Let us discuss the three possible outcomes:

- $n^j = 0$: If information costs are very high, the cost of applying a negligence rule might be too high when compared with the reduction in allocative loss it would entail. The legal system might find it optimal to adopt no liability.

- $n^j = z$: When information costs are negligible (the injurer's behavior is easily verifiable), the optimal negligence criterion might be omni-comprehensive: all of the injurer's precautionary measures are included in the determination of negligence. This is indeed an extreme case, and is unlikely to occur in practice when administrative costs are positive.[33]

- $0 < n^j < z$: In intermediate cases, the negligence criterion includes only some of the injurer's precautionary measures, while the rest are

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[33] See Shavell (1987:30) on this point.

omitted as being too expensive to verify and/or not affecting the allocative loss to any substantial extent.

Once the scope of the negligence criterion has been optimally set at n^j, the due level of precaution should also be set at the socially optimal level x^j. It is worthwhile to note that, in all three cases illustrated above, it is socially optimal that the victim takes all his precautionary measures $\bar{n} = \bar{\bar{z}}$ at the optimal level $\bar{x}^j$. Section B in the appendix offers considerations concerning the injurer's compliance with the negligence rule described in this section and about the victim's compliance with the negligence rule described in the following section.

5.2.2. Setting the negligence criterion when the injurer is the residual bearer (negligence applies to the victim)

Under strict-liability-based rules, the negligence criterion can also be straightforwardly set at the optimal scope $\bar{n}^v$ and at the optimal level $\bar{x}^v$. As before, three major cases might result with respect to the scope of negligence:

- $\bar{n}^v = 0$: Strict liability.

- $\bar{n}^v = \bar{\bar{z}}$: Strict liability with a defense of omni-comprehensive contributory negligence.

- $0 < \bar{n}^v < \bar{\bar{z}}$: Strict liability with a defense of contributory negligence.

5.2.3. Choosing the residual bearer when administrative costs are positive

In a world with positive administrative costs, the optimal simple negligence (or no liability) rule is not necessarily equivalent to the optimal strict-liability-based rule, as the optimal scope of the negligence criterion might be less than omni-comprehensive in either or both cases. The optimal liability rule is that rule which triggers the least social (allocative and administrative) costs. Thus, the residual bearer should be optimally chosen in order to minimize three different costs: the total accident costs, the information costs of verifying either the injurer's or the victim's behavior, and the compensation costs that arise when the injurer is the residual bearer. Exp. (10) provides a formal scale to balance these costs.

Figure 1 depicts the former results and shows that, when administrative costs are introduced, the equivalence between liability rules disappears. The optimal scope of the negligence criterion in fact varies depending on whether the residual bearer is the injurer or the victim. In either or both cases, the

negligence inquiry may be efficiently limited to some precautionary measures only, or a strict rule (no liability, $n=0$, or strict liability, $\bar{n}=0$) may be optimal. The figure depicts the case in which both n^j and $\bar{n}^v$ are positive but less than z and $\bar{z}$, respectively. Furthermore, n^j and $\bar{n}^v$ do not necessarily trigger the same level of total social cost. In the example shown in the figure, n^j triggers lower social costs, thus the residual bearer should be the victim.
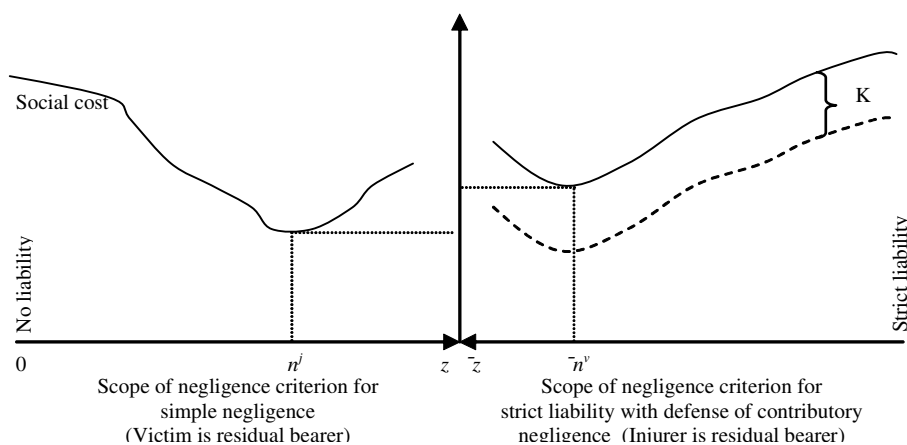
Figure 1   Scope of the negligence criterion and social costs under liability rules with positive administrative costs

In addition, the figure also shows how the presence of compensation costs undermines the performance of strict-liability-based rules. In the case shown in the figure, without compensation costs K, strict liability with defense of contributory negligence would be superior to simple negligence. The presence of compensation costs K alters the balance between simple negligence and no liability on the one hand and strict-liability-based rules on the other hand, and makes the latter considerably more preferable than it would be otherwise.

6. POLICY IMPLICATIONS: STRICT LIABILITY VERSUS NEGLIGENCE

Tort law and economics scholarship has stated that strict liability should be implemented whenever the injurer's activity is more dangerous than the victim's.[34] My contention is instead that there are at least two other criteria to be implemented which may enable the analyst to justify the actual (and historical) use of strict liability in cases in which the injurer's activity is clearly not more dangerous than the victim's. In fact, we have seen that the verifiability of parties' behavior[35] and the impact of compensation costs bears on the choice of the liability rule as much as the dangerousness of the activity.

  In Exp. (10), I have provided a formal criterion for the choice of the residual bearer, given an optimal determination of negligence. I shall break down this criterion into three components:

> (*i*)   *Dangerousness*: the residual bearer should be the party whose activity level triggers greater accident costs (whose activity is more "dangerous"). $L(n^j)$ is a measure of those accident costs due to the fact that some of the injurer's precautionary measures are excluded from the negligence criterion (the injurer's activity level). Therefore, $L(n)$ can be interpreted as the dangerousness of the injurer's activity. $\overline{L}(\overline{n}^v)$ is the dangerousness of the victim's activity. If $L(n^j) < \overline{L}(\overline{n}^v)$, the victim's activity is more dangerous: the dangerousness criterion requires choosing the victim as the residual bearer, therefore implementing simple negligence or no liability. Otherwise, a strict-liability-based rule would be desirable.[36]

> (*ii*)   *Verifiability*: the residual bearer should be that party whose precautionary measures are more expensive to verify under the negligence inquiry. $I(n^j)$ is the cost of verifying the injurer's precautionary measures under the optimal (no-liability or) simple-

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[34] See Shavell (1980a). On this point Shavell (1987:29) notes that "if it is more important to control injurers' level of activity than victims,'" then the rule that results in greater social welfare is strict liability. See also Landes and Posner (1987:70) on the same issue. The legal system should otherwise adopt the negligence rule. In turn, the "importance" of controlling one party's activity can be interpreted in terms of the riskiness or dangerousness of that party's activity (Shavell, 1987:31-32).

[35] This point is close to the analysis of compliance error by Grady (1994, 1998), showing that strict liability is employed in areas in which the cost of verifying parties' behavior under a negligence inquiry would be too high.

[36] The dangerousness criterion was advanced by Shavell (1980a).

negligence rule; $\bar{I}(\bar{n}^v)$ is the cost of verifying the victim's precautionary measures under the optimal strict-liability-based rule. If $I(n^j) < \bar{I}(\bar{n}^v)$, verifying the victim is more expensive, and hence (no liability) or simple negligence is to be chosen. A strict-liability-based rule would be desirable otherwise.[37]

(*iii*) *Fixed compensation costs.* Simple negligence and no liability do not trigger fixed compensation costs *K*, while strict-liability-based rules do. Therefore, choosing the victim as the residual bearer saves administrative costs.

Contrary to commonly-held beliefs, no one of these components is sufficient alone. This approach provides some interesting insights on the comparative statics and the dynamics of liability systems.

6.1. A SYNCHRONIC PERSPECTIVE: "STRICT LIABILITY VS. NEGLIGENCE" AND ADMINISTRATIVE COSTS

The dangerousness criterion has provided a classical and broadly accepted explanation for the choice of the strict liability regime over negligence; however, it is admittedly "somewhat rough,"[38] because, as Shavell (1987:31-32) notes, "the choices made between strict liability and negligence rules are not always easy to explain on the basis of differences in riskiness."[39] I contend that a more comprehensive explanation may be provided by considering the interplay of the dangerousness element with the other two described above.[40]

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[37] Alchian and Demsetz (1972) describe the firm as an institution in which one of the inputs to a joint production specializes in monitoring the others. The problem of "who will monitor the monitor" is solved by giving the monitor the title to the net earnings of the team (Alchian and Demsetz, 1972:782). The verifiability criterion proposed in this article follows the same logic. One of the two inputs to the team production consisting of accident prevention (namely the input that is easier to monitor) is directly monitored through the negligence criterion, while the other input is given residual liability. In the economic analysis of tort liability, the verifiability criterion dates back to the analysis by Grady (1988).

[38] Shavell (1987:32).

[39] Shavell (1987:31): "Is the chance of a wild animal escaping from a zoo and doing harm, for which strict liability would probably result in the United States, greater than that of an automobile running down a pedestrian, for which the negligence rule would govern?"

[40] Faure (2002:372) correctly points out that the informational problem may bear on the choice between strict liability and negligence only if in reference to the determination of negligence. If finding information about causation is the problem, the use of strict liability would not help. In the analytical framework of this article, causation is assumed to be satisfactorily established.

By considering different examples of strict liability, I provide some hypotheses for future comparative analysis.

The case of ultra-hazardous activities is said to represent the most open application of strict liability by English and American courts,[41] and by the courts in civil law countries as well.[42] Strict liability, however, is not justified by dangerousness alone, but also by the abnormality of the activity. The activity must not be "a matter of common usage."[43] In fact, in support of my hypothesis, activities that imply a high but typical risk (such as driving)[44] are excluded.[45]

There are other instances in which strict liability is implemented for activities that are clearly not dangerous.[46] These cases may be explained by the fact that verifying the injurer's behavior is, under some circumstances, more difficult than verifying the victim's behavior.[47] Legal commentators often explicitly point to this informational aspect as the rationale for the rule.[48]

It is remarkable that, even in those jurisdictions that do not openly apply strict liability, the negligence rule may be covertly made to approximate strict liability by means of an "objective" standard of negligence, extremely high due care levels, and doctrines such as *res ipsa loquitur*. Alternatively, the fault principle might be retained in its entirety and paired with the reversal of the burden of proof.[49]

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[41] *Rylands v. Fletcher* (1868) LR 3 HL 330 and 519 (I) Restatement (Second) of Torts (1965). See Fleming (1983:302).

[42] See for example article 2050 of the Italian civil code, which represents an advance over earlier continental codes (Stone, 1972).

[43] 520 Restatement (Second) of Torts (1965).

[44] See Rogers (2002) and Schwartz (2002) for English and American law respectively.

[45] In *Rylands v. Fletcher*, the reference is to *non-natural* use. See also Dias and Markesinis (1989:346-347) on the interpretation of non-natural as unusual or non-ordinary rather than artificial.

[46] Zweigert and Kötz (1998:671) note that the domain of strict liability encompasses two categories of situations: activities that entail particular risk, and activities with respect to which the injurer's fault is particularly difficult to prove.

[47] See Fedtke and Magnus (2002:156) on the implementation of strict liability in German law in cases of plaintiffs facing extreme difficulties in proving fault on the part of the defendant. See Tichý (2002:86) on Czech law. See du Perron and van Boom (2002:245) on Dutch law. Gilead (2002:195) observes that in Israel "dangerousness per se can hardly justify strict liability" as "fault-based liability provides adequate protection against dangerousness by adjusting the level of care to the magnitude of the risk."

[48] See Koch and Kotziol (2002b:411).

[49] See Zweigert and Kötz (1998:653) and Grady (1994:894).

The fact that similar instances are regulated by strict liability in one jurisdiction and yet subject to the reversal of the burden of proof in another suggests that both measures respond to the same problem of gathering information on and verifying the injurer's behavior, as in the following examples.

Liability for damages caused by animals is generally strict,[50] irrespective of the dangerous nature of the individual animal.[51] Species not considered dangerous often fall under such a regime.[52] When negligence applies, the burden of proof is often reversed.[53] Derelict buildings trigger the application of strict liability or the reversal of the burden of proof in most cases,[54] as do thrown[55] or falling[56] things, since "in many cases, the activity or negligence of some person cannot be demonstrated."[57] Damages caused by things may furnish another example along the same lines. Although in some instances the general principle of fault is applied, many legal systems make a broad use of strict liability.[58] For example, liability is strict in Austria and Germany for damages caused by

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[50] English, French, German and American law know at least some instances of strict liability. See Koch and Kotziol (2002b:396-398).

[51] English law, in section 2(1) of the 1971 Animals Act, applies strict liability to dangerous animals that are not commonly domesticated in the British Isles, see section 6(1). The application of strict liability is triggered by the characteristics of the species and not of the individual animal within a species. Strict liability also applies to dogs that injure or kill livestock (section 3). See Fleming (1983), Dias and Markesinis (1989), and Epstein (1999).

[52] English law applies strict liability to damages caused by straying livestock, as regulated by section 4 of the 1971 Animals Act; sheep and poultry also fall in this category. See Dias and Markesinis (1989:360).

[53] Austria, Italy and Switzerland opt for a reversal of the burden of proof.

[54] French, Belgian and Italian law adopt a presumption of responsibility; common law makes general use of strict liability, although it employs fault for damages to persons in the premises. German law presumes injurer's fault.

[55] Civil law countries follow the Roman tradition of dealing with these instances under a strict liability regime, while common law requires fault.

[56] In general, strict liability or presumed responsibility is largely applied.

[57] Stone (1972:32).

[58] French law (art 1384 par I of the Code Civil) holds the custodian strictly liable for damages caused by things, irrespective of the intrinsically or potentially dangerous nature of the thing. See Zweigert and Kötz (1998:661) and Galand-Carval (2002). The Italian Codice Civile encompasses a similar rule in art. 2051, see Busnelli and Comandé (2002). See also for German law Fedtke and Magnus (2002:174).

genetically modified organisms,[59] in Austria for inadequate public computer services,[60] and in Spain for damages caused by noxious fumes.[61]

6.2. A DIACHRONIC PERSPECTIVE: THE EVOLUTION OF LIABILITY RULES

The same arguments may be used to suggest a theoretical framework for the evolution of liability systems.[62] I maintain that there is a tendency for liability rules to respond not only to the degree of risk produced by human activities, but also to the informational characteristics thereof. Hence, even if the riskiness of certain activities were constant over time, an erratic variation of liability rules might be justified by a corresponding change in the cost of acquiring information about such activities.[63] The idea that the determination of negligence changes over time depending on changes in technology and society was illustrated by Grady (1988) at 299-301 and 303-307, who stressed the fact that changes in technology may render care-taking more effective but also more difficult to observe.

  In their early appearance, liability systems seem to adopt mainly strict liability.[64] This choice seems to be difficult to justify solely in terms of risk, since modern activities are often more dangerous. Instead, in the early stages of the development of liability systems, information costs are likely to be extremely high for two reasons. First, negligence may be difficult to prove due to the lack of fundamentals such as a good understanding of the laws of

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[59] See Fedtke and Magnus (2002). Koch and Kotziol (2002b) note that the rule has been introduced for fear of innovative technologies rather than of high risk.

[60] Koch and Kotziol (2002a).

[61] See Martin-Casals et al. (2002).

[62] For a law and economics analysis of the genesis of liability in ancient law, see Parisi (2001).

[63] Along the same lines, Landes and Posner (1987:107-122) provide several efficiency justifications for strict liability. In particular, at 115 they remark that "During the early stage of the development of a new product or activity, the legal system lacks sufficient experience to be able to determine whether the benefit of the product exceeds its full cost […] One way to generate such information is to hold the producer or the user strictly liable."

[64] Roman law first developed a strict liability regime. In addition, at the beginning, the Roman tradition produced liability rules based on strict liability only for specified wrongs; the rest would fall under no liability. The *leges XII tabularum* and the *lex Aquilia* listed a series of wrongs that had to be restored through compensation. The requirement of *damnum iniuria datum* for those wrongs which triggered liability initially literally meant "a wrong committed against the law." Hence, only those wrongs admitted by the law could entitle the victim to compensation. Limitations also followed from the application of the *corpore corpori* principle, which gave rise to compensation only for those wrongs materially committed by the injurer and resulting in material harm for the victim. See Parisi (1992, 2001) for a discussion of the problem from a legal viewpoint and a vast bibliography.

nature, developed systems of writing and recordkeeping,[65] and sufficient judicial expertise. The application of the negligence criterion may also increase litigation as it creates animosity.[66] Therefore, the choice of the liability rule is mainly a choice between no liability and strict liability.[67]

In modern legal systems, liability rules tend to move towards a more generalized application of negligence. Given the superiority of negligence rules in terms of incentives (they spur both parties' precaution), legal systems move in this direction as soon as the information costs decrease below the allocative gains. Information costs decrease when literacy and knowledge develop, resulting in increased judicial expertise. This justifies a move away from strict rules towards rules that implement a negligence inquiry.

However, information costs also depend on the complexity of the parties' actions, which in turn depend on social and technological development. In those areas of torts where the parties' actions become more complex (as in the production of certain goods), information costs might increase and thereby justify strict rules. Negligence rules become more common, although strict rules survive in some specific areas.[68]

7. CONCLUSION

In his seminal work, Calabresi (1970) suggested that the optimal choice of liability rules ought also to minimize administrative costs, next to the total accident costs. The literature on tort law and economics has built refined models mainly on the latter category of costs, while the issue of minimizing the administrative costs has been relegated to an informal comparison of the

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[65] Posner (1980).

[66] Parisi (1992:33-34, 56-58).

[67] English and American legal history seems to confirm this pattern too, as it developed from the strict liability format and slowly evolved towards negligence; not until the 19th century was there any general acceptance of the fault principle. See Fleming (1983:300) on this point. The early common law's main concern was with intentional torts and, even later, attention was drawn to the nature of the victim's harm rather than to the injurer's behavior. Rudimentary requirements of causation were used to select accident losses for which the victim should be entitled to compensation, regardless of the negligence of either party. See White (1980:3 ff.) and Fleming (1983:97).

[68] Isaac (1918) singles out three periods of dominant strict liability in English law: (i) the 11th century, around the time of the Norman conquest, (ii) the 14th century, at the time of Edward I, and (iii) the beginning of the 20th century. Fault was the dominant criterion for liability in between those periods. Isaac justifies such cyclical dynamics as an attempt to approach the goals of ethics. At 967, he speaks of the "swinging of the pendulum between strict rules and negligence rules." See also Koch and Kotziol (2002b).

different liability rules, with particular attention to comparative negligence, and has yielded no widely accepted results.

In this study, I have attempted to show that administrative costs bear not only on the choice of which liability rule to implement, but also on the setting of the optimal negligence criterion. In particular, I have shown how an increase in the administrative costs of the system reduces the optimal *scope* of the negligence rule, that is, it curbs the number of precautionary measures that courts will consider relevant for a finding of negligence.

In fact, the optimal scope of negligence balances the advantages of a broader scope, in terms of better incentives, with its administrative costs. The need to restrict the scope of negligence should not be interpreted (as it is often argued) as a failure of the liability system; to the contrary, it signals an efficient allocation of resources between two competing goals:[69] one of reducing accident costs and the other of minimizing the costs of the system. I have shown how this perspective may shed some light on the choice between different liability regimes (in particular, strict liability versus negligence) and on the historical dynamics of tort law and hopefully direct attention to the multidimensional character of precaution.

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[69] It has been said that the notion itself of activity level as a proxy for those precautionary measures that escape the determination of negligence "undermined the confidence in the efficiency of tort law." See Donohue (1989:1058). Shavell (1987:25) entitles paragraph 2.3.6 "The source of the defect of the negligence rule." However, as we have contended, this is only true if administrative costs are not considered. The broader picture provided in this article demonstrates that restricting the scope of negligence is efficient.

Appendix

A. If there are no administrative costs and the negligence criterion is optimally set, then parties' compliance with the negligence criterion is a Nash equilibrium.

Let us consider simple negligence. The negligence criterion is optimally set: $N=(x^*, n^*)$. The injurer is considered not liable if he takes at least all the precautionary measures in the negligence criterion at the optimal levels. He is liable and pays damages otherwise. If he complies with the negligence criterion, he bears a cost equal to x^*. If he does not, he pays the cost of precaution and the expected accident loss. It is worthwhile noticing that assumptions (I) and (IV) guarantee that if the injurer takes the $n^* = \underline{z}$ precautionary measures and spends x^* on precaution, the internal allocation of such expenditure among the different precautionary measures that is optimal for the injurer corresponds to the negligence criterion. The injurer's cost function is:

$$(11) \quad \min_{x,n}\begin{cases} x & \text{if} & x \geq x^* \quad and \quad n = n^* \\ l(x,n,\overline{x},\overline{n}) + x & \text{otherwise} \end{cases}.$$

It is immediately evident that there is no incentive to take more precaution than is required; thus the cost of compliance is x^*, allocated among the n^* prescribed precautionary measures (first line in (11)). Moreover, there is no incentive to take less precaution because, given the victim's choice of $\overline{x}^*$ and $\overline{n}^*$, the injurer's cost $l(x,n,\overline{x}^*,\overline{n}^*) + x$ is minimized by x^* and n^* by hypothesis (second line in (11)). Thus, the injurer has no incentive to deviate from (x^*, n^*). Likewise, the victim has no incentive to deviate from $(\overline{x}^*, \overline{n}^*)$ since, given the injurer's choice, the victim bears $l(x^*,n^*,\overline{x},\overline{n}) + \overline{x}$, which is minimized by $\overline{x}^*$ and $\overline{n}^*$.

In situations where the amount of damages that a negligent injurer must pay is diminished by the loss that would have occurred anyway had he been non-negligent (Grady, 1983, and Kahan, 1989), the injurer cost function becomes:

$$(12) \quad \min_{x,n}\begin{cases} x & \text{if} & x \geq x^* \quad and \quad n = n^* \\ l(x,n,\overline{x},\overline{n}) - l(x^*,n^*,\overline{x},\overline{n}) + x & \text{otherwise} \end{cases}.$$

It is easy to show that in this case parties will also take the optimal level and the optimal scope of precaution in equilibrium. The proof is analogous to the case of strict liability with defense of contributory negligence.

B. *If administrative costs are positive, the negligence criterion is optimally set, the residual bearer is optimally chosen, and parties bear all socially relevant costs, then parties' compliance with the negligence criterion is a Nash equilibrium. If parties do not fully bear all socially relevant costs, then a party may be induced to reduce his level of precaution (and hence be negligent) while expanding the scope of his precaution.*

With positive administrative costs, if parties also bear costs I and K, the proof of the previous section applies with some appropriate modifications. If parties do not bear these costs, a party may be induced to reduce his level of precaution while expanding the scope of his precaution, thereby externalizing some costs (information and/or compensation) on society.

To illustrate, let us show that an injurer under simple negligence may be induced not to comply with an optimally set negligence criterion. The injurer's decision whether or not to comply with the negligence criterion may be interpreted as a choice between simple negligence and strict liability, as follows.

Consider an optimally designed simple negligence rule with $N=(x^j, n^j)$, that is, assume:

a) n^j minimizes $L(n)+I(n)$; i.e. n^j is the optimal scope of the negligence criterion;

b) x^j minimizes $l(x, n^j, \bar{x}^j, \bar{n}^*) + x + \bar{x}^j$, given the victim's optimal precaution expenditure $\bar{x}^j$; i.e., x^j is the optimal level of the negligence criterion;

c) $L(n^j) + I(n^j) \leq \bar{L}(\bar{n}) + \bar{I}(\bar{n}) + K$, for any $\bar{n}$; i.e., the victim is the optimal residual bearer.

The injurer's cost function is:

$$(13) \qquad \min_{x,n} \begin{cases} x & \text{if} & x \geq x^j \quad and \quad n \geq n^j \\ l(x, n, \bar{x}, \bar{n}) + x & \text{otherwise} \end{cases}.$$

Non-negligent injurers (first line in (13)) bear x^j. Negligent injurers (second line in (13)) bear $l(x, n*, 0, 0) + x$, provided that victims of negligent injurers bear no accident costs and therefore take no precaution, and that negligent injurers take all their precautionary measures, given assumption (III) in the text.[70] Let $x^\wedge$ denote the level of x that minimizes these costs. This is an equilibrium if $x^j > l(x^\wedge, n*, 0, 0) + x^\wedge$, which may be compatible with the optimality conditions imposed supra.

In fact, the former expression would imply the following inequality

$$l(x^j, n^j, \overline{x}^j, \overline{n}*) + x^j + \overline{x}^j + I(n^j) > l(x^\wedge, n*, 0, 0) + x^\wedge + 0 \qquad \text{or}$$

$L(n^j) + I(n^j) > \overline{L}(0) + \overline{I}(0)$, which means that in those cases in which the injurer is induced to be negligent, simple negligence must be inferior to a rule of strict liability when $K = 0$. Therefore, for the outcome to be compatible with the requirements of condition c) imposed supra, the compensation costs K ought to be at least such that $K > L(n^j) + I(n^j) - \overline{L}(0)$. If compensation costs are sufficiently high, the injurer's noncompliance with the negligence criterion is compatible with condition c). Conditions a) and b) are evidently compatible with this outcome. Thus, it is possible for the injurer's cost to be lower when he does not comply with the negligence standard than when he complies.

It is important to remark that because the Grady-Kahan model lowers the cost of noncompliance by subtracting the cost of those accidents that would have occurred anyway, this form of the negligence rule facilitates the injurer's decision not to comply. Formally, the condition for injurers not to comply becomes $x^j > x^\wedge + l(x^\wedge, n*, 0, 0) - l(x^j, n^j, \overline{x}, \overline{n})$, which is clearly more easily satisfied than $x^j > x^\wedge + l(x^\wedge, n*, 0, 0)$.

In addition, let us emphasize two necessary conditions for the injurer not to comply with an optimal negligence criterion under simple negligence:

1) $x^j > x*$;

2) $x^j > x^\wedge$.

Let us first provide an interpretation of these conditions and then show that they are necessary for noncompliance. Condition 1) states that the optimal

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[70] If we assume that the injurer's decision not to comply is not anticipated by the victim, and that hence the victim still takes optimal precaution, the cost for the negligent injurer will be even lower (as the victim's precaution reduces the accident costs he bears) and therefore his incentives not to comply will be even stronger. Moreover, since the negligent injurer is no longer bound by the negligence criterion, he takes precaution with respect to all his precautionary measures, exactly as under strict liability.

level of the injurer's precaution under simple negligence ought to be higher than the optimal level under an omni-comprehensive simple negligence rule. The difference between the two is that in the former case some of the injurer's precautionary measures are omitted from the negligence criterion (and consequently not taken by the injurer), while the victim takes, to the contrary, all his precautionary measures in both instances.

An interpretation of $x^j > x^*$ may be that the injurer's precautionary measures omitted are substitutes for precautionary measures that are taken instead by the injurer or by the victim. If $x^j \leq x^*$, then we can write $x^j \leq x^* < l(x^*, n^*, \overline{x}^*, \overline{n}^*) + x^* + \overline{x}^* < l(x^\wedge, n^*, 0, 0) + x^\wedge + 0$, by definition of x^*, where the second inequality is self-evident and the third follows from the definition of x^*. From the first and the last terms it is evident that condition 1) is a necessary condition for noncompliance.

Condition 2) states that the optimal level of the injurer's precaution under simple negligence ought to be higher than the optimal level under strict liability. Under the former, the victim takes all his precautionary measures and the injurer takes only those that are included in the negligence criterion; under the latter the injurer takes all his precautionary measures but the victim takes none. An interpretation of $x^j > x^\wedge$ may be that the injurer's precautionary measures are substitutes for the (untaken) victim's. If $x^j \leq x^\wedge$, then we can write $x^j < l(x^\wedge, n^*, 0, 0) + x^\wedge$, which clearly implies compliance. Thus, condition 2) is a necessary condition for noncompliance.

To conclude, the problem of parties' noncompliance can be tackled from different angles. If parties were made to bear information and compensation costs, private and social incentives would again be aligned. Alternatively, the legal system might choose to disregard these costs in the first place and opt for a rule that simply minimizes expected accident costs. A third possibility is that the *level* of precaution which the parties are required to take under negligence could be lowered below the first-best optimal level, in order to lower the cost of compliance and remove the incentive to deviate.

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