Negligence among the Risk-Averse:

The Importance of Defendants' Wealth

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Abstract: This short piece uses economic analysis to study negligence standards given that individuals are risk-averse. The non-linearities of risk-aversion make a formal mathematical model not solvable analytically, but a numerical example using assumptions that may be appropriate for necessary activities such as transportation or recreation, shows the effects of wealth on care. The analysis shows that the wealth of the defendant should influence the negligence standard to prevent an excessive quantity of risky conduct, as well as to redistribute the ability to engage in the risky activity from the wealthy to the less well off. Moreover, this analysis is illustrative of the limitations that requiring tractable analytical models places on economic analysis of law.

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* Professor, University of Connecticut School of Law. Copyright Nicholas L. Georgakopoulos; permission for unlimited academic use is hereby granted. I wish to thank {… for their invaluable comments and {. *Mathematica* is a registered trademark of Wolfram Research, Inc. {Maybe discuss: precise vs vague adjudication and wealthy committing clear violations; with insurance the poor can reduce care and increase conduct, like the rich; if the limit is vague, the rich can also afford to take chances by encroaching the limit

I. INTRODUCTION

The analysis of negligence in the literature of economic analysis of law assumes risk neutrality. This obviously gigantic assumption, however, is necessary in order to build a generalizable model that allows us to draw normative implications, i.e., a model that can be considered more than an isolated example. The imposition of risk-neutrality, however, skews the models in an obvious way. Defendant wealth appears not to be relevant to the normative questions involved in the negligence standard, and makes the hostility that juries exhibit to deep-pocket defendants appear paradoxical. This brief piece analyzes negligence under a conventional model of risk-aversion. Taking risk-aversion into account makes the model intractable; therefore, results are extracted from simulations. The analysis shows that disparities in wealth are important.

First, the model examines the choice of care and quantity of risky conduct by internalizing individuals, or, which is equivalent, by individuals facing strict liability. Focusing on the rich, the next section examines their choice of conduct under a negligence standard equal to the average of conducts in the internalizing society and refines a point known to the literature, that defendants increase the quantity of their risky conduct. The third section finds that the excessive risky conduct of the rich can be checked by increasing the negligence limit. Finally, the conclusion toys with the normative implications of the analysis. Negligence appears not so much necessary for controlling the level of risk of activities, but more to redistribute the quantity of risky activities in which different wealth-groups engage.

II. THE MODEL

Risk-aversion influences our analysis of conduct because it changes the reactions of individuals faced with uncertain outcomes. The possibility of an accident, and the further possibility of a finding of negligence liability in case of unreasonable care, are typical uncertainties that could be examined using the standard mathematical approximations (models) of risk-averse decision making. Let us start with the constant relative risk aversion formula $u(w)=\frac{1-a}{w^{1-a}}$, which for a=1 is substituted by the simpler and more tractable natural logarithm function u(w)=ln(w).[1] Individuals who enjoy their wealth according to this function would be risk-averse because they would prefer a certain gain (of, for example, 10% of their wealth), to an actuarially equivalent gamble (such as spinning a fair coin for 20% or nothing). Constant relative risk aversion is an attractive method to simulate actual tendencies because wealth creates an apparent tolerance for risk which agrees with the impression that wealthy individuals take more risks. To analyze negligence incentives, we must apply this decision-making tool to individuals' choices of care and quantity of risky conduct. The first step is to examine the simpler version of the problem, i.e., individuals' choices if liability was not uncertain, and the only uncertainty regarded whether an accident would occur. This environment corresponds to a regime of strict liability or to one where actors internalize the consequences of their accidents.

A. Care and Risk under Strict Liability

Spending **s** on the safety of each one of **g** products or activities influences the probability **p(s)** of accidents per unit of the risky good or activity, where the price of each unit is **c+s.** Thus, **c** is the primary cost of the activity and **s** is the added safety expenditure, e.g., the cost of a basic car is **c** and the premium for the same car made safer is **s**. Spending should have a diminishing effect on safety so that the probability of accidents declines with safety expenditure (**p'(s)**<0) but with diminishing rate (**p''(s)**>0). Only one accident can occur; multiple accidents are impossible.[2] If an accident occurs, damages **d** are paid. Buying **g** units of

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1 Using different values for **a,** the coefficient of risk-aversion, would not change the nature of the results. Greater risk-aversion will only result in reduced utility from entertaining the risk of paying damages and a stronger incentive to avoid conduct that may lead to liability. For an introduction to the discussion of risk-aversion, see Kenneth Arrow, *The Theory of Risk-Aversion*, reprinted in 3 COLLECTED PAPERS OF KENNETH ARROW 147 (1984). Constant relative risk aversion adjusts the change in the desirability of additional dollars by wealth, so that the wealth-adjusted ratio of the rate of change of enjoyment of each additional dollar to the marginal enjoyment of the last is constant. The resulting differential equation $wu''(w)/u'(w)=-a$, after dropping the constants of integration, has the above general solutions for $a\neq1$ and $a=1$, respectively.

2 This assumption reduces the importance of spending on safety and of reducing risky conduct. It runs, therefore, contrary to my conclusions regarding their importance; relaxing this assumption will not have qualitative effects on the conclusions. However, there is a normative implication in this assumption: If the level of the risky conduct can be taken into

the risky good increases the consumer's utility by **f(g)**. This is again subject to diminishing returns and, therefore, is concave, i.e., **f'(g)**>0 and **f''(g)**<0.

Since the probability **p** of an accident is a function of safety expense **s**, the expected utility of the individual will be the weighted sum of the utility in the case that no accident occurs and in the case an accident does occur. The probability that no accident will occur is **[1-p(s)g]**. The individual's wealth will be reduced by the cost **c** and safety expense **s** that correspond to each of the **g** units consumed, **u[w-g(c+s)]**, and his welfare will increase by the enjoyment of the **g** units, **f(g)**. An accident will occur with probability **p(s)g** and the only influence it will have on our individual's welfare is the payment of damages **d**. Thus, the expected utility **eu** is:

$$eu = \left[1 - p(s)g\right]\left[u(w - g(c+s)) + f(g)\right] + \\ + p(s)g\left[u(w - g(c+s) - d) + f(g)\right]$$

Suppose we know that the per-unit probability of an accident occurring is **p(s)**=1/(**a s+1)** (this, again, corresponds to diminishing returns from precaution **s**; further expenditures on safety have a diminishing impact; the probability of accidents ranges from 1 to 0 as care goes from 0 to infinity), and that the enjoyment of **g** units of the risky good produces welfare **f(g)**=**b ln(g)**. This functional form of enjoyment from the activity also exhibits dicreasing marginal returns from it but has the additional feature that very small ammounts of the activity are very undesirable; therefore it is considered here an appropriate approximation of the enjoyment of necessities, such as transportation. The individual, of course, chooses both the quantity of activities or goods and their safety together. To derive the optimum amount of dangerous activity and care, we would take the derivative of expected utility with respect to each of **s** and **g**, equate them to zero and solve the system for **s** and **g** to find the extremes of expected utility.[3] Here, however, the

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account by the court, then it should be part of the negligence standard (one who drives 1,000 miles a week perhaps should take more precautions than one driving 100 miles a week). Wealth, however, enables potential injurers to engage in more risky activities that will not be related to the activity that caused the injury or may be complementary to it. It is possible to reduce the point of this analysis to the claim that all of a defendant's risky activities should be cumulatively analyzed when trying to establish whether he was negligent for an accident.

[3] The second derivatives would then confirm whether this extreme is a maximum or minimum.

system is not solvable. Thus, the numerical calculation of maximizing conduct is necessary, but substituting numbers for variables presents the danger that our conclusions are no longer generalizable. This fear should be allayed in this case, because it is obvious that the shapes of expected utility remain analogous for most risky activities and coefficients of risk-aversion.

The study of this problem using a=.9,c=2,d=15,b=.75, and wealth w of either 20 or 40 produces the following figures:

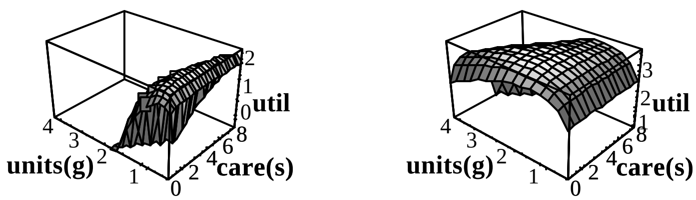

Figure 1: The utility that choices of care and quantity of dangerous activity or consumption produce in two individuals of different wealth (poorer to the left).

We see that the two individuals will differ dramatically in the quantity of the dangerous conduct they will undertake, even under strict liability. The following table captures their choices:

	Units(g)	*Care(s)*	*Util*	*p(s)g*
Poor	.6	3.18	2.1	.155
Rich	1.82	2.81	3.55	.515

The rich individual, of course, can afford more of this attractive product or conduct and, therefore, reaches a higher level of welfare. The rich also exercises less care per unit of dangerous activity than the poor. After taking into account the amount **g** of the activity in which each engages, the rich is accepting a much more likely accident. Increased wealth translates into a greater ability to withstand the liability an accident may cause. Effectively, the rich is self-insuring while the poor only gets a taste of the activity and spends lots on care. That is no aberration of this example. The following illustration shows the optimal choices of individuals (using this example's parameters) as wealth ranges from 16 to 100. Increased wealth initially increases, but soon starts reducing, care.

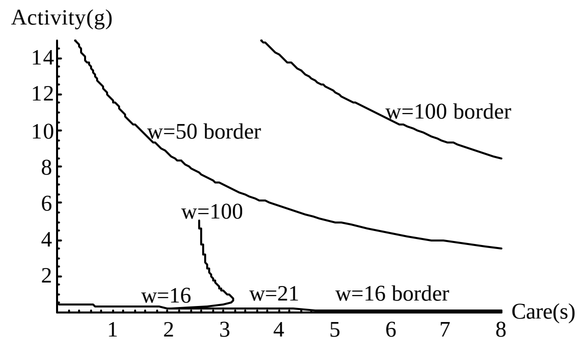

Figure 2 plots the optimal choices of care and units of consumption or activity as wealth changes (from w=16 to w=100). The maximum care occurs at a wealth of w=21. This figure also illustrates how the general shape of utility remains similar to the previous figures as wealth changes by plotting the border beyond which utility is not defined.

The generality of the shape of how wealth changes care is indicated by the following figure. The risk of the activity is allowed to have different degrees of controllability (small **a** implies risk reduction is expensive) and the activity is desired with different intensities (large **b** implies greater desirability). When safety becomes cheaper, spending on care drops, and disproportionately more so for the rich who self-insure. As the activity becomes less desirable, the rich who increasingly self-insure undertake it in proportionately greater quantities. They consume proportionally more than the poor and take proportionally less care. Counter-intuitively, as the desirability of the activity decreases, the importance that it be safe increases. Individuals who engage in the activity do not derive as great a utility from it to justify taking risks. When the activity is less desirable, preserving other funds' safety is more important. If the activity is more desirable, greater financial risks are justified when consuming it.

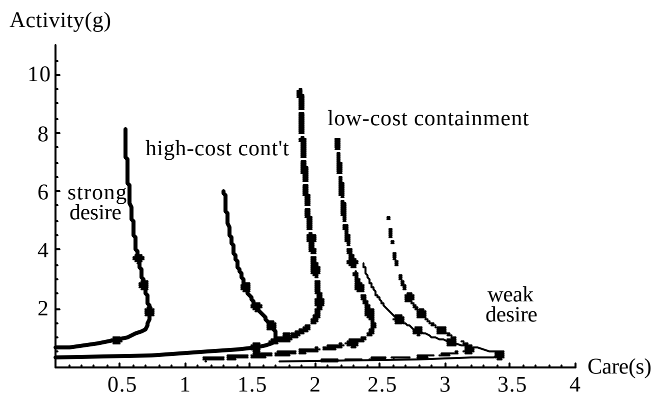

Figure 3 shows the effect of changes in the desirability of the activity and how controllable its risk is. It also illustrates the effect of changing the degree of aversion to risk existing in society. Each line follows wealth from 16 to 100 using a risk-aversion coefficient of 1. The heaviest lines correspond to a more desirable risky activity (**b**=2.25; labeled "strong desire"), and the lighter ones to a less desirable one (**b**=0.75; labeled "weak desire"). The three solid shorter and more spaced lines correspond to an activity the risk of which is more costly to control (**a**=.2; labeled "high-cost cont[ainmen]t"), while the others to an activity with more controllable risk (**a**=.9; labeled "low-cost containment"). The dots on these lines correspond to wealth of **w**=20, 30, 40 and 50. The shapes, although changing, are consistent: (1) Initial increases in wealth lead to purchases of more safety rather than more of the risky activity. The best use to which the poor can put additional funds is to reduce risk, not to increase the activity. (2) Further increases in wealth lead to self-insurance which allows individuals to increase the quantity of the risky activity and reduce safety expenditure. (3) Reduced desirability of the conduct accentuates the importance of other funds. Therefore, reduced desirability leads to more spending on care. That in every case a small region exists where increases in wealth lead to increases in care does not interfere with the analysis. If those increases in care straddle the negligence limit, only the rich can comply. If the negligence limit is to their left, the rich are allowed by the negligence rule to externalize risk.

The next step is to pick the negligence rule, i.e., the standard of care to which these individuals will be subject. If they meet the standard of care, they will not be liable for the damage their conduct would cause. The issue becomes to induce optimal care while the negligence rule allows externalizing the consequences of accidents.

B. *Care by the Wealthy under a Single Negligence Standard*

Let us see how the above pictures would look under a unitary (single; not depending on wealth) standard of negligence. Strict liability induced different levels of care. Their average will be, for now, the negligence standard.

A new form of expected utility must be calculated. If a potential injurer uses care equal or greater than the limit, this injurer will never be liable for accidents. Therefore, as long as care is no less than the limit, the utility, $\mathbf{u_c}$, of those complying with the negligence standard is deterministic, regardless of accidents:

$u_c=u[w-g(c+s)]+b\ ln(g)$

The potential injurer faces two possible expected utility functions, depending upon whether care falls below the level **l** proscribed by negligence liability, or above. Obviously, relieved from liability for the accidents their conduct will cause, the rich and the poor alike will pursue more dangerous conduct. The following graph of expected utility shows that the effect is a discontinuity in the plot of expected utility at the point of compliance.

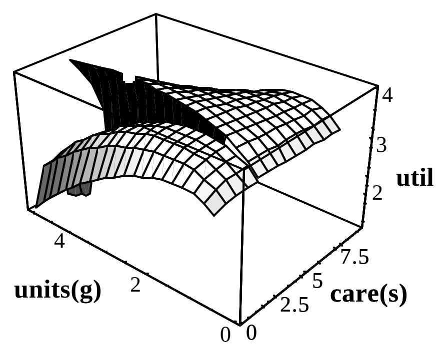

Figure 4: The expected utility of the rich under a negligence rule. The gray dot points out the maximizing conduct.

The figure of the expected utility under a negligence rule is unsurprising. Complying increases utility, producing a discontinuity at the level of care that absolves from liability. A maximum amount of conduct still exists by virtue of the diminishing returns, but it is much higher than the level of conduct under strict liability. Obviously, taking more care than necessary to avoid liability decreases utility because no gain is obtained from the additional care.

C. *Imposing Increased Care on the Wealthy*

The shape of the complying utility, however, shows that a higher negligence standard would lead individuals to reduce the amount of the risky conduct. We can easily determine the standard of care that would induce the same amount of dangerous activity as strict liability. First we calculate the amount of activity that maximizes utility if the level of care were given. Take **du/dg**, the derivative of utility with respect to **g**, equate it to zero and solve for **g** (that is the amount of risky activity that maximizes utility given a level of care). Set the resulting formula for **g** equal to the conduct **r** that should be induced, and solve for **s** to determine the negligence standard that will induce this amount of activity. The result simplifies to s=[bw-(b+1)cr]/[r(b+1)]. The following figures compare the utility of the rich subject to the original or the elevated standard of care.

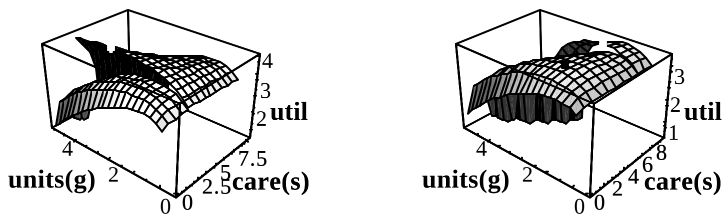

Figure 5: The effect of increasing the care due by the rich (figure on the right plots the increased standard of care). The dots indicate the local maxima.

The heightened standard obviously reduces the utility attainable by the rich. However, it raises the question whether they will comply with the elevated standard or breach and apply the lower amount of care that they would use under strict liability. The following table shows the available choices and their ramifications, indicating that, in this case, the rich is better off by complying with the elevated negligence standard:

Wealth	*Care Due*	*Units*	*Care(s)*	*Util*	*p(s)g*
rich	Strict Liab'ty	1. 82	2.81	3.55	.515
rich	Average	3.43	3.0	4.05	.928
rich	Elevated	1.82	7.43	3.58	.237

Thus, we see, that subjecting the wealthy to elevated standards of care increases care and reduces their risky activity. The increase in care may be suboptimal from a social perspective, since strict liability would result in less care, but it is clearly superior to a unitary negligence standard which increases the dangerous activity with no additional care. Thus, the reduction in activity appears as the principal reason behind the elevated care. A further increased standard of care, however, could induce the rich to violate the negligence standard and operate as if in a strict-liability regime. It is important to note, however, that if the rich were to follow this strict-liability conduct he may face punitive damages since he would be blatantly disregarding the negligence limit. This is a clearly undesirable outcome and presents the rich with a catch-22 that is to the society's disadvantage. Society may be better off if the rich reduces care without increasing the risky activity (the additional care is probably wasteful). This analysis implies an argument that that punitive damages should be reserved for the rich who violate with increased conduct, not decreased care. That they would not, may well imply that punitive damages in negligence are wrong.

One might think that we must also examine the desirability of a lower standard of negligence for the poor. That the poor are subjected to a negligence rule, however, immediately increases the amount of risky conduct they will undertake. Of course, further increases would be possible if the negligence standard were further lowered. Since their increased conduct, however, seems to be taking society already away from its optimal, no reason for further lenience toward the poor appears to exist.

III. CONCLUSION

This brief examination showed that varying the level of care utilized to determine negligence liability by taking into account the wealth of the defendant is a fertile issue.[4] Far from dismissing the tendency of juries to take defendant wealth into account, we see that, unless facing a higher standard of care, wealthy defendants will engage in much more of the risky conduct than they would if they fully internalized its consequences. This increase is greater than that of non-wealthy injurers. Moreover, the increased activity will take place using the lesser precaution imposed by the general negligence standard. Increasing the standard of care for the wealthy will cause them to dramatically scale back their activity, approaching the internalizing levels, while increasing

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[4] To the extent that skill is correlated with wealth, it is important to note how consonant this conclusion is with the fact that superior skill does impose an elevated standard of negligence on the defendant.

care. Violating the negligence limit may become less unattractive to the wealthy who face high standards of care, but even if they choose to be negligent, they are likely to reduce care to the internalizing level without engaging in more of the conduct.

In other words, the negligence system does not so much influence care as it reallocates activity. It imposes excessive care and curtails the activity of the wealthy, as well as induces more activity by the non-wealthy. Society appears unconcerned that Ted Turner may shy away from some risky activity but concerned that little grandmothers may shy away from any activity.

An important normative tangent that is beyond this piece regards the welfare of society. If social welfare is the sum of individual utilities, a system which induces care any different than the internalizing optimum will be suboptimal. This relationship breaks, however, if the risky activity causes increases in wealth that the individuals fail to internalize (such as long-term growth from technological innovations brought about by risk-takers akin to the Wright brothers), or if the administration of a justice system based on strict liability would be so burdensome as to reduce welfare by more than the second-best of negligence liability.