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ARTICLES

TORT LIABILITY FOR SOFTWARE DEVELOPERS: A LAW & ECONOMICS PERSPECTIVE

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Abstract: This article explores the economic rationale for applying product liability law to computer software. As demonstrated below, a well-designed liability regime must place liability upon all parties who economically control the risks of accidents. Accordingly, this article finds that strict liability may be appropriate for certain types of "intrinsic" software, but not for other types of software that require the customer to be actively involved in the selection, operation, and maintenance thereof. We show that for this type of "extrinsic" software, a strict liability rule is unlikely to be economically optimal and, therefore, choosing a generic liability regime applicable to all forms of software is ill-advised. Instead, a more nuanced approach is required to achieve a desirable policy outcome.

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I. INTRODUCTION

Few can disagree that computer software is the brain of the Information Economy. Indeed, readily available off-the-shelf software now performs increasingly sophisticated tasks by not only allowing us to manage our own personal finances, but by allowing entrepreneurs to create small businesses that grow the economy. We also use software to perform routine, pedestrian tasks that were once left entirely to Industrial Age gears, chains, and pulleys, such as software that tells the antilock braking system on automobiles precisely how to brake when a driver presses on the pedal in a panic.

But since software is a product of human ingenuity, software can, like humans, fail. These failures can range from the annoying (such as the need to reboot a personal computer) to the catastrophic (improperly working medical equipment).[1] Tort law addresses the liability consequences of these types of failures for all types of products and services, and there have been calls in recent years to subject all software manufacturers to liability for software defects, particularly through product liability lawsuits.[2]

In this article, we explore the economic rationale for applying strict liability principles to different types of software. At its core, the goal of the American product liability legal regime is economic efficiency—the law tries to incent manufacturers to take into account the potential harms that their products may cause to the public in the most efficient manner possible.[3] Stated simply, a strict liability rule holds a firm re-

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1. *See*, *e.g.*, Julia A. Tyde, *Medical Computer Software: Rx for Deadly Errors,* 4 SOFTWARE L.J. 117 (1990); Michael C. Gemignani, *Product Liability and Software*, 8 RUTGERS COMPUTER & TECH. L.J. 173 (1981); and Susan Nycum, *Liability for Malfunction of a Computer Program*, 7 RUTGERS COMPUTER & TECH. L.J. 1 (1979). Examples of the potential deadliness of software-related errors are numerous. In Panama, for example, a number of cancer patients died when a software glitch led to excessive doses of radiation. Society for Radiological Protection, *Radiological Accident at National Oncology Institute in Panama* (June 9, 2001), http://www.srp-uk.org/servpanama.html.

2. *See*, *e.g.*, Frances E. Zollers, et al., *No More Soft Landings for Software: Liability for Defects in an Industry that has Come of Age*, 21 SANTA CLARA COMPUTER & HIGH TECH. L.J. 745 (2005); Peter A. Alces, *Whither Warranty: The Bloom of Products Liability Theory in Cases of Deficient Software Design,* 87 CAL. L. REV. 269 (1999); Tyde, *supra* note 1.

3. For example, the issue of providing the correct incentives for commercial software design is becoming particularly acute with the growing importance of promoting cybersecurity. Indeed, according to the Obama Administration's recent Cyberspace Policy Review:

> [t]he Federal government should consider options for incentivizing collective action and enhance competition in the development of cybersecurity solutions. For example, the legal concepts for "standard of care" to date do not exist for cyberspace. Possible incentives include adjustments to liability considerations (reduced liability in exchange for improved security or increased liability for the consequences of poor security), indemnification, tax incentives, and new regulatory requirements and compliance mechanisms. CYBERSPACE POLICY REVIEW: ASSURING

sponsible for all physical damage caused by a defective product that it produces regardless of whether the firm is negligent in the design or production of that product. As a result, strict liability rules are applied to the occurrences of latent product defects in mass-manufactured industrial products, like tires, based on a belief that other rules (like negligence) would be inefficient. But we show below that constructing a similar economic justification for this strict liability rule is not possible for all types of software categorically. Indeed, we show that strict liability is unlikely to be economically optimal for some types of software, given the significant involvement of the customer in the selection, operation, and maintenance of that software.

Key to our analysis is the distinction between "intrinsic" and "extrinsic" software.[4] Intrinsic software is a component of a "complete product," such as microwave ovens or automobiles. For intrinsic software, the consumer or user of the device does not interact directly with the software (and, in many cases, like the case of antilock brakes, may have no idea the software is even there). Extrinsic software, on the other hand, is typically loaded onto a machine (such as a computer) by the user and the user has a direct interface to the software. The end- user also usually purchases extrinsic software directly, allowing the customer to evaluate the full price of the product, which includes expected accident losses.

As we discuss in detail below, the difference in the user experience between intrinsic and extrinsic software may be key to a socially efficient liability regime, because the economic theory of product liability law prescribes the assignment of liability to the party who controls the risk (in an economic rather than purely technical sense).[5] While strict liability or negligence regimes may be appropriate for intrinsic software, a strict liability rule may not be socially optimal for extrinsic software, because that rule would not induce the consumer to exercise due care in the installation, operation, and use of the software. Because consumers have interactions with the selection and operation of extrinsic software, in many cases some accounting of contributory negligence of the consumer's behavior is necessary for the liability rule to allocate resources effi-

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A TRUSTED AND RESILIENT INFORMATION AND COMMUNICATIONS INFRASTRUCTURE, *available at* http://www.whitehouse.gov/assets/documents/Cyberspace_Policy_Policy_Review_final.pdf.

4. Roger Clarke, *Who is Liable for Software Errors? Proposed New Product Liability Law in Australia*, http://www.anu.edu.au/people/Roger.Clarke/SOS/PaperLiaby.html. We also recognize a third type of software category in which large businesses contract out for customized software solutions. However, as this type of transaction is generally governed by detailed end-user license agreements ("EULAs") among sophisticated entities where issues such as warranties and allocations of liabilities have been negotiated at arm's length, discussion of this type of software is beyond the scope of this article. *Id.*

5. In other words, it must be economic (in a cost-benefit sense) for a party to control accident risks and not simply a technical feasibility.

ciently. It follows, then, that choosing a generic liability regime applicable to all forms of software is probably ill-advised.

Section II begins with a brief discussion of product liability law and how the debate over applying it to software has moved through a number of phases. Commentators have in the past debated whether software is a "service" or a "product" (for which different liability rules apply), whether software is "speech" and therefore protected by the First Amendment, or whether a software manufacturer can relieve itself of liability through end-user license agreements ("EULAs"). Section II shows that the general purpose of product liability law is, at its core, economic efficiency and that rules of liability have changed over time to take into account the different types of products that might cause harm.[6] The economy's growing dependence on software means that calls for software developer liability will not go away and might even be expected to increase. As a result, it is appropriate to begin to consider what would be an efficient regime for assigning liability for failures.

In Sections III and IV, we examine the economics of product liability from economic "first principles." To facilitate this analysis, we first determine what the most optimal social outcome would be for each of the three basic types of legal theories of product liability (no liability, strict liability, and negligence) under four general theoretical scenarios. These theoretical scenarios range from unilateral accidents in which the victim cannot affect the probability of an accident (such as antilock brake software failing to apply the brakes) to bilateral accidents in which the victim can take actions that contribute to the likelihood of an accident (such as a failure to keep antivirus software up-to-date). We then refine this analysis under several scenarios where the victims are the purchasers of the software and the injurers are firms. Section V applies the analysis developed in Sections III and IV to discuss what liability regime for particular types of software would be optimal for overall social welfare.

Our analysis is by no means complete. Liability is a complex issue and no single treatment of the issue can be exhaustive. Our purpose is primarily to review the basic economic theory of liability and evaluate how software may fit into that framework. Our review of the literature on software liability suggests this effort is worthwhile, since in many cases the economic analysis of liability is substantially ignored. All the

6. Our focus in this article is upon the operation of tort law and not other legal regimes. Tort law is only one area in which the law attempts to deter undesirable conduct. Contract law and criminal law are the two other areas. Contract law is of course particularly relevant to software, because EULAs can and often do allocate liability between the software developer and customer. That said, in situations in which transactions costs are low, there is no reason to believe that contractual provisions will not allocate liability efficiently or effectively.

factors that influence optimality in liability vary across a wide spectrum of software types. Consequently, strong conclusions are precluded. Nevertheless, the theory we outline does provide significant general guidance on appropriate liability regimes for the software industry.

II. THE LEGAL CHALLENGE OF SOFTWARE LIABILITY

Given the dangers of excessive litigation, rules of liability for software defects are an important issue, given that Information Technology has been a key driver of productivity and economic growth in the United States. Noted economic scholar Dale Jorgenson published empirical evidence indicating the "development and deployment of information technology is the foundation of the American growth resurgence[, and c]omputers have been the predominant impetus to faster growth, but communications equipment and software have made important contributions as well."[7] Other studies support the vital role of information technology for economic growth. Oliner and Sichel's econometric analysis reveals that information technology accounts "for about two-thirds of the acceleration in labor productivity. . . between the first and second halves of the 1990s." The contribution of Information Technology to economic growth approximately doubled between the first and second-halves of the 1990s.[8] Stiroh concludes "the industries experiencing the largest productivity acceleration in the late 1990s were the producers and most intensive users of information technology."[9] Because of the important role software plays in the economy, it is important that the law "get it right" in ascribing liability rules for software glitches so as not to unnecessarily discourage innovation and growth in the industry.

A. The Purpose and Development of Product Liability Rules

In the words of Judge Richard Posner, "many areas of the law, especially—but by no means only—the great common law fields of property, torts, crimes, and contracts, bear the stamp of economic reasoning."[10]

7. Dale W. Jorgenson, *Information Technology and the U.S. Economy*, 91 Am. Econ. Rev. 1, 2 (2001). Jorgenson attributes much of the productivity and growth to semiconductors, but observes that "both software and hardware are essential for information technology." *Id.* at 7.

8. Stephen D. Oliner & Daniel E. Sichel, *The Resurgence of Growth in the Late 1990s: Is Information Technology the Story?*, 14 J. Econ. Perspectives 3, tbl. 1 (Fall 2000). As for economic growth, Information Technology accounts for about 23% of economic growth, with software representing 30% of this contribution. Computer hardware is useless without software (and vice versa), so it is difficult to conceptualize how the contributions of hardware and software can be evaluated independently. *Id.*

9. Kevin J. Stiroh, *Investing in Information Technology: Productivity Payoffs for U.S. Industries*, 7 Current Issues in Econ. & Fin. 1 (2001).

10. Richard A. Posner, The Economic Analysis of Law 18 (1977).

The purpose of rules in these legal regimes is to shape and deter conduct by parties so that the productive potential of society is maximized. In order for efficiency to be achieved, actions (such as striking a neighbor, committing theft, or selling a defective product) that cause more harm to society than good must be appropriately deterred. As a result, the law ascribes to parties different forms of responsibility or liability for "bad acts," "wrongful" conduct, or actions that harm others or property.[11]

Law and economics scholars like Posner posit that all of the basic fields of law share this trait. Criminal law is included as a sometimes severe form of punishment that may be necessary in order to protect the important economic concept of private property and ownership. Contract law, by contrast, is designed not to punish those who breach contracts but to protect and make more efficient the process of exchange.[12]

Product liability is a form of tort law that has been developed and refined over time with the express purpose of incenting the proper care in the manufacture, sale, and use of goods that might be defective and cause injury. Until the Industrial Age, liability for defective products was considered a branch of contract law and the terms of liability were established only between the producer and immediate purchaser of the product. As industrial production grew and wholesalers and distributors of goods rose in prominence, the limitation of liability for defective goods only to the first purchaser of the product (increasingly a middleman) was seen as artificial and eventually became repudiated by American courts in the early part of the last century.[13]

Courts and state legislatures have since decided that for particular types of products, strict liability would be the best means of ensuring that those products be manufactured with the appropriate standard of care. When applied, strict liability makes a manufacturer responsible for all physical injuries and associated losses caused by a defective product that it produces, without regard to whether the manufacturer was negligent in its design or manufacturing decisions.[14] In addition, the manufacturer would be held responsible for all property damage and in-

11. Notably, liability is not intended as punishment for wrongdoing or harm. In some cases, harm can result without any malice, such as someone breaking into a cabin to survive a blizzard. Liability is intended to ensure that the cabin door is repaired, not as punishment. *See*, *e.g.*, Talbot Page, *On Strict Liability: Reply to Hausman and Schwartz*, 97 ETHICS 817 (1987).

12. Posner asserts that the economic function of contract law is to (1) "maintain appropriate incentives;" (2) "reduce the complexity and hence cost of transactions by supplying a set of normal terms that, in the absence of a law of contracts, the parties would have to negotiate expressly;" and (3) "furnish prospective transacting parties with information concerning the many contingencies that may defeat an exchange, and hence to assist them in planning their exchange sensibly." POSNER, *supra* note 10, at 69.

13. MacPherson v. Buick Motor Co., 111 N.E. 1050 (1916).

14. RESTATEMENT (SECOND) OF TORTS § 402A (1998).

jury caused by a defective product, even if that damage or injury was suffered by a person or firm not a party to the contract for the sale of that product.[15] Put another way, strict liability makes the producer of a product an insurer for all physical harm caused by that product.

Courts have posited economic efficiency rationales to justify applying a strict liability rule for certain products.[16] Advocates of strict liability assert that because all products have the potential to do some harm, for a regime to be efficient, the full potential for harm must be balanced against the benefits of that product.[17] The only way to ensure that a product is priced and distributed at economically optimal levels, advocates argue, is to make one party—the manufacturer—liable for all harms, regardless of any concept of "negligence" or "fault."[18] This is because the manufacturer is in the best position to know all potential defects and potential harms that its product might cause and balance those harms against the value (profitability) of the product. This argument is based on an assumption about the party that economically controls the risk of accidents and this argument may or may not hold for any given product or service.[19]

Strict liability is not applied to all products and services in the economy.[20] The rationale courts and legislatures use in deciding whether to apply strict liability to a particular product is based on three core policies:[21]

> **1. Loss-Spreading:** Courts indicate that a strict liability rule is appropriate if the manufacturer is in the "best position" to absorb and plan for the cost of the loss due to a defective product.[22] By making the manufacturer responsible for all losses, it will supposedly be able to spread the cost of this loss to all users of the product through a higher price.[23]
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> **2. Understanding of Potential Defects; Actions and Reliance by the End User:** A strict liability rule may also be appropriate if the end

15. *Id.*

16. POSNER, *supra* note 10, at 197.

17. *Id.*

18. *Id.* at 198.

19. For a seminal treatment advocating strict liability for products cases, see RICHARD A. EPSTEIN, MODERN PRODUCTS LIABILITY LAW (1980). Other commentators focus on the administrative costs of negligence rules in advocating strict liability rules for other torts. *See, e.g.,* Guido Calabresi & John Hirschoff, *Toward a Test for Strict Liability in Torts,* 81 YALE L. J. 1055 (1972).

20. RESTATEMENT (SECOND) OF TORTS § 402A cmt. f.

21. *See* Michael R. Maule, *Applying Strict Products Liability to Computer Software*, 27 TULSA L.J. 735, 740 (1992); *see generally* RESTATEMENT (THIRD) OF TORTS: PRODUCT LIABILITY ch. 1 (1998).

22. RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY § 2(b); RESTATEMENT (SECOND) OF TORTS § 402A cmt. c.

23. Maule, *supra* note 21, at 743.

user of a product cannot be reasonably relied upon to discover potential flaws in a particular product.[24] For example, a consumer cannot generally be expected to spot a defect in the wiring of a toaster that causes it to explode when a poppy seed bagel is inserted; it is more efficient for society to place the burden of investigating and alleviating such a defect upon the manufacturer. At the same time, a consumer can generally be expected to understand that he should not toss a plugged-in toaster into a full bathtub.

3. Safety: Some commentators assert that assigning full and strict liability to the manufacturer will result in the socially-optimal level of production; otherwise, too many harmful products will be produced.[25] Even if there is no "fault" involved in the damage caused by a product, strict liability ensures that risky activities that are inherent in certain types of businesses and industries will be curtailed to a certain extent.

That said, the application of these principles by courts and lawmakers is by no means always optimal. Product liability cases often take on the patina of moral responsibility or "fairness" that often clouds judgment and the realization of the most "efficient" result.[26] The legal regime's confusion of morality with social welfare is, of course, not new or even unique to this area of the law. In 1897, Justice Oliver Wendell Holmes lamented in observing that "judges themselves have failed adequately to recognize their duty of weighing considerations of social advantage."[27]

There are two important points to take from this brief discussion of product liability law. First, and most importantly, *product liability law is certainly flavored by the consideration of efficiency and incentives.* The purpose of liability is not to lay blame or punish bad actors, and it is not about "stamping out" the distribution of "bad" products. Liability law attempts to make sure that products are produced and distributed to the public at appropriate prices and quantities of distribution. Inherently dangerous yet tremendously valuable products—like hammers and hot tubs—are still produced and sold in our economy, but they are simply sold pursuant to a legal regime that allocates the risk of harm between

24. Greenman v. Yuba Power Products, Inc., 377 P.2d 897 (Cal. 1962).

25. *See* Zollers, et al., *supra* note 2. Whether these commentators are correct is, of course, an empirical question. Judge Posner believes that strict liability might, on the other hand, over-deter investment and development of new products. Richard A. Posner, *Strict Liability: A Comment,* 2 J. LEGAL STUD. 205 (1973).

26. In addition, the potential in some states for juries to award punitive and noneconomic damages in products liability suits certainly undermines the argument that such lawsuits are solely directed at fostering economic efficiency. *See* Ted Frank, *Rollover Economics: Arbitrary and Capricious Product Liability Regimes,* 1 AEI LIABILITY OUTLOOK (Jan. 2007), *available at* http://www.aei.org/docLib/20070104_LiabilityOutlookPosted_g.pdf.

27. Oliver Wendell Holmes, Jr., *The Path of the Law*, 10 HARV. L. REV. 457, 467 (1897).

producers and consumers in what courts and legislatures have decided is an economically optimal fashion.

Second, *liability law changes with the times.* Before the Industrial Revolution, liability rules were radically different than those today. A consumer could only recover damages if she was the original purchaser of the product, a practice that might have made sense where goods were produced and sold locally from artisan craftsmen.[28] That regime changed to one of strict liability as factories and large manufacturing firms took over production and distribution. As a result, the purposes of strict liability are generally best interpreted in light of mass-manufactured products like toasters or tires: manufacturers of such products are essentially in the best position to understand potential product defects and therefore alter the risk of accidents.[29] But blindly applying rules designed for toasters to shrink-wrapped software would be a mistake because the characteristics of those products differ substantially.[30] As we discuss below, that same assumption may not be necessarily the case for certain types of software since users provide an influential role in accident risk.

B. The Hurdles of Applying Product Liability Law to Software

For nearly two decades, legal writers have contemplated applying strict product liability law to software. A number of hurdles exist to pursuing such claims, the most important being the distinction that courts have drawn between a "product," a "service," and "information."[31] In applying these distinctions, courts have implicitly understood that principles of strict liability are malleable and must be tailored to the particular item in question. For example, providers of a "service" are not held strictly liable for injuries and are instead held to a particular "standard of care."[32] The purpose of a service provider is generally to provide expert knowledge to consumers.[33] Applying "strict liability" to a medical doctor's course of treatment for a sick patient would be seen as anathema, even by the most hardened member of the medical malpractice

28. Restatement (Second) of Torts § 402A cmt. b.

29. Maule, *supra* note 21, at 743.

30. The preeminent legal realist, Justice Holmes, repeatedly wrote on the need for law to evolve and adapt to modern conditions.

> For the rational study of the law the blackletter man may be the man of the present, but the man of the future is the man of statistics and the master of economics. It is revolting to have no better reason for a rule of law than that so it was laid down in the time of Henry IV. It is still more revolting if the grounds upon which it was laid down have vanished long since, and the rule simply persists from blind imitation of the past. Holmes, *supra* note 27, at 469.

31. Restatement (Second) of Torts: Products Liability § 19(b).

32. Maule, *supra* note 21, at 746.

33. *Id.*

plaintiff bar. A doctor stands in quite a different position than a mass producer of a product that might contain defects.

For similar reasons, providers of items containing certain forms of "information" have been exempted from strict product liability, even in cases where the item in question has been mass produced. A famous line of cases (sometimes called the "Book Cases")[34] usefully outline the parameters for this analysis. The basic structure of these "Book Cases" is the same: a publisher publishes a book (like an encyclopedia) that contains incorrect information; the reader of the book follows the book and is injured; and the injured reader sues for damages.[35]

In general, the "Book Cases" indicate that the provision of technical information upon which the consumer should be expected to rely—such as the publication of an incorrect scale on an aeronautical chart that resulted in a crash—warrant the application of strict liability.[36] True to the nature of strict liability, in the 1980s, Jeppesen—a publisher of incorrect aeronautical charts—was even held liable for charts that were faulty due to mistakes made by the Federal Aviation Administration ("FAA").[37]

These cases demonstrate the willingness of courts to assign strict liability for products that are designed to perform a particular purpose (in those cases, correct aeronautical maps). But not every "Book Case" ascribed strict liability to bungling publishers. The most important "Book Case" for our analysis is *Winter v. G.P. Putnam's Sons*,[38] in which the book *The Encyclopedia of Mushrooms* contained incorrect information about the edibility of a particular mushroom. Predictably, the critically ill reader sued, but the court ruled that the information in the *Encyclopedia* was not a "product" and that strict liability would not apply.[39] In its decision, the court implicitly recognized that different types of information could result in different liability rules. The *Winter* court did indicate in *dicta* that certain types of computer software could be regarded more like the Jeppesen aeronautical charts but stated that applying strict liability to the content of the *Encyclopedia of Mushrooms* would be improper:

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34. Zollers, et al., *supra* note 2, at 758.

35. *Id.* at 758-59.

36. *See* Aetna Cas. & Surety Co. v. Jeppesen & Co., 642 F.2d 339 (9th Cir. 1981). Jeppesen & Co. was sued multiple times for these faulty charts. *See* Saloomey v. Jeppesen & Co., 707 F.2d 671, 676-77 (2nd Cir. 1983) (noting that the charts "reached [the pilot] without any individual or tailoring or substantial change in contents—they were simply mass-produced. . . Jeppesen undertook a special responsibility, as a seller, to insure that consumers will not be injured by use of the charts").

37. Brocklesby v. United States, 767 F.2d 1288 (9th Cir. 1985).

38. Winter v. G.P. Putnam's Sons, 938 F.2d 1033 (9th Cir. 1991).

39. *Id.* at 1036.

> Aeronautical charts are highly technical tools. . . The best analogy to an aeronautical chart is a compass. Both may be used to guide an individual who is engaged in an activity requiring certain knowledge of natural features. Computer software that fails to yield the result for which it was designed may be another. In contrast, [*The Encyclopedia of Mushrooms*] is like a book on how to use a compass or an aeronautical chart. The chart itself is like a physical 'product' while the 'How to Use' book is pure thought and expression.[40]

Citing similar reasons, courts refused to apply strict liability to a textbook that misstated the steps of a chemistry experiment[41] and a cookbook that failed to mention that an ingredient is toxic when eaten raw.[42]

Despite some original claims that the *dicta* in *Winter* would spur product liability suits against software producers, such litigation has not yet become prevalent, particularly because of the economic loss rule.[43] The recovery of economic loss (as opposed to compensation for injury to a body or property) can generally be limited by the terms of the contract of sale.[44] In addition, a successful plaintiff would generally need to show that a piece of software was subject to a "design defect," which requires that the plaintiff prove the presence of a "reasonable alternative" design that would have avoided the injury.[45] Other barriers to successful product liability cases against software developers are proof of causation and "state of the art" defenses that are recognized in many states.

Despite these hurdles, product liability cases against software manufacturers should be expected to rise as software proliferates. The "Book Cases" highlight an important distinction in the law and lay the foundation for our economic analysis below. Software performs a multitude of

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40. *Id.*

41. Walter v. Bauer, 439 N.Y.S.2d 821 (N.Y. App. Div. 1981).

42. Cardozo v. True, 342 So.2d 1053 (Fla. Dist. Ct. App. 1977).

43. *See* Maule, *supra* note 21, at 740.

44. *See* Douglas E. Phillips, *When Software Fails: Emerging Standards of Vendor Liability Under the Uniform Commercial Code*, 50 BUS. LAW. 151 (1994). Software companies have utilized contractual terms (EULAs) to attempt to limit their damages for economic losses. In instances where limiting terms in the EULA are not present, economic damages have been awarded. *See also* Zollers et al., *supra* note 2, at 764-65, n.119 (citing *Latham & Assoc., Inc. v. William Raveis Real Estate, Inc.*, No. 22 90 46, 1990 Conn. Super. LEXIS 688 (Conn. Super. Ct. May 10, 1990); *Italo v. Monteleone*, No. 83C-DE-70, 1986 Del. Super. LEXIS 1222 (Del. Super Ct. May 27, 1986); *Winterbotham v. Computer Corps, Inc.*, 490 So. 2d 1282 (Fla. Dist. Ct. App. 1986); *Carbur's, Inc. v. A & S Office Concepts, Inc.*, 445 A.2d 1109 (N.H. 1982)).

45. RESTATEMENT (THIRD) TORTS: PRODUCTS LIABILITY § 2(b) states that in a "design defect" case, strict liability would apply only if the "foreseeable risks of harm posed by the product could have been reduced or avoided by the adoption of a reasonable alternative. . . and the omission of the alternative design renders the product not reasonably safe." One commenter has noted that this definition of design defect "is reminiscent of the negligence standard." Zollers et al., *supra* note 2, at 778.

tasks and cannot be regarded monolithically, just as information in a book can vary. Often, one will see the aeronautical chart cases cited by proponents of strict liability for software that attempt to gloss over the important distinction made by the *Winter* court. For example, Zollers, et al. stated:

> The aeronautical charts cases provide a more perfect analogy to software than the book cases for a number of reasons. First, the charts are functional and not literary. There can be no purpose for aeronautical charts other than their function to aid pilots. Similarly, software has no purpose other than to cause a computer to perform some function. While it is true that the how-to books, such as recipe books, and mushroom hunting books are functional, they are a small subset of all books.[46]

Of course, merely noting that how-to books are only a "small subset" of books provides the policymaker little guidance. Also, the "functional" nature of software has little meaning when selecting an economically efficient liability regime.

In summary, legal scholarship to date on the question of product liability for software glitches has generally approached the question by essentially trying to define what software "is" in relation to current law. But the question of applying a strict liability rule should not be left to strained analogies as to whether Microsoft Word looks "more like" a "recipe book" than a work of Proust. The rationale for applying strict liability is generally economic, so economic reasoning should be applied to the question. Once one accepts that the purpose of the legal regime is to minimize social costs (and not demand retribution for every software bug), one therefore necessarily must recognize one of the important limits of a strict liability rule: that imposing strict liability "on one party almost inevitably discourages another party from taking adequate precautions."[47]

Section III provides a "first principles" analysis of various theories of liability as they might be applied to various types of computer software. In essence, economic theory prescribes the application of liability to the party that economically controls accident risk. If only the seller of an item can influence risk in a cost effective manner, then strict liability may be appropriate. However, if *both* buyer and seller can economically impact accident losses, then strict liability is not an optimal liability regime. We argue that this difference is significant when contemplating liability for software, since software has a variety of forms and purposes. Other factors also influence the need for software liability and the opti-

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46. *Id.* at 763.

47. Douglas D. Lichtman & Eric A. Posner, *Holding Internet Service Providers Accountable* (July 2004) at 21, *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=573502#PaperDownload.

mal liability regimes for the industry, some of which we mentioned above (e.g., loss spreading).

III. THE ECONOMICS OF LIABILITY

In this section, we present the basic economic theory of liability, drawing heavily from the work of economist Steven Shavell of the Harvard Law School.[48] The purpose of the theory is to find a liability regime that *minimizes the social cost of accidents* under particular scenarios. In later sections, we evaluate the difference in the economic theory when the parties are firm and consumer. We consider three alternative liability regimes: (a) no liability; (b) strict liability; and (c) a negligence rule. In some cases, we assess the effect of adding the defense of contributory negligence to the latter two regimes.

In the model, there are injurers and victims, and both are assumed risk-neutral. Put simply, a risk-neutral person is indifferent between a certain payment of $1,000 and an even chance of winning either $2,000 or $0.[49] In order to reveal the underlying logic of the economic theory of liability, we evaluate the liability regimes in a variety of scenarios. For example, it is possible that either party (bilateral accident), or just one (unilateral accident), can exercise care in order to reduce the probability of an accident occurring. Additionally, we will consider a case where the probability of an accident is affected by the level of activity of the injurers or victims (e.g., the amount of time riding a bicycle). Liability regimes when injurer and victim and seller and buyer are also considered.

A. Unilateral Accidents with No Activity

We begin our analysis with the simplest case, that of unilateral accident. In our example, only the injurer can exercise care in order to reduce the probability of an accident.[50] Recall that the goal of the liability regime is to minimize the overall social cost of accidents—it is not to eliminate accidents entirely. As a result, an ideal legal rule applied to unilateral accidents would have the injurer pay to avoid an accident so long as the incremental benefit exceeds the incremental cost of reducing

48. Steven Shavell, Foundations of Economic Analysis of Law (2004) [hereinafter Foundations of Economic Analysis]; Steven Shavell, Economic Analysis of Accident Law (1987); Louis Kaplow & Steven Shavell, *Economic Analysis of Law in* Handbook of Public Economics 1661-1784 (A. J. Auerbach & M. Feldstein (2002) eds., 2002). Dr. Shavell's website contains numerous research papers on liability, http://www.law.harvard.edu/faculty/shavell/.

49. The expected payoff of the gamble is $1,000 (0.5·$2,000 + 0.5·$0 = $1,000).

50. We could also concoct examples where the victim is the only party that can exercise care, though the ideal liability regime would not be identical in the alternative. For example, strict liability on the firm has no effect on accident risk, since the firm cannot control such risk.

the probability of an accident. If the incremental cost of reducing the probability of an accident is greater than the associated incremental reduction in damage caused by the accident, then social welfare is harmed if the injurer incurs costs to further avoid an accident.

Table 1 summarizes the underlying calculations of the economic model in the most basic of scenarios. In this example, there is unilateral care and the activity level of either party has no effect on the probability of an accident. Say, for example, an accident results in a loss of $100 and only the injurer can exercise care to affect the probability of the accident. With no level of care, the probability the accident occurs is 20%, so the expected accident loss is $20 (= 0.2 x 100) with risk neutrality. The total social cost of the accident is $20, since there are no costs incurred to affect the probability of the accident. Now, assume it costs the injurer $10 to exercise Moderate care, which reduces the probability of the accident to only 5%. Now, the expected accident loss is $5 and the total social costs are $15 ($10 in care and $5 in expected loss). Finally, at a cost of $15 the probability of the accident can be reduced to 3%, indicating diminishing marginal returns with respect to care. With a High level of care, social costs are $18.

Table 1. Care, Accident Risk, and Social Costs

Care Level	*Cost of Care*	*Accident Probability*	*Accident Loss*	*Expected Accident Loss*	*Total Social Cost*
None	$0	20%	$100	$20	$20
Moderate	$10	5%	$100	$5	$15
High	$15	3%	$100	$3	$18

Given an objective of minimizing the social costs of accidents, the optimal level of care for a unilateral accident with no activity is Moderate care, with a total social cost of $15. While increasing the level of care to High reduces the accident probability and expected loss by $2, it costs $5 to do so. Thus, the "benefit" of reducing accident loss ($2) is smaller than the cost ($5), so increasing the level of care to High is not socially beneficial. Using the example in Table 1, we can evaluate the behavior of the injurers and injured using the three liability regimes and determine and compare the level of care exercised by the participants.

1. *No Liability*

With a no liability rule, the injurer pays the victim nothing in the case of an accident. Thus, the injurer chooses to exercise no care, because any cost of care exceeds the injurer's private benefit (which is zero). In this case, where the victim cannot affect the probability of an accident, the total social cost of the accident is $20, which is greater than

the social welfare maximizing loss of $15. So, "no liability" is not an optimal regime in unilateral accidents where only the injurer can exercise care.

2. *Strict Liability*

With strict liability, the injurer must fully compensate the victim in the case of an accident. Thus, the injurer must incur both the cost of care and expected accident losses, so the injurer's private costs are equal to the total social costs (i.e., the cost of care plus expected accident losses). With strict liability, therefore, the injurer is incented to minimize total social costs and provide the socially optimal level of care, or Moderate care in our example. Exercising a High level of care is not socially desirable since it costs an additional $5 but only reduces accident costs by $2.

3. *Negligence Rule*

With a negligence rule, the injurer is liable for accident losses only if the accident was a consequence of the injurer's own negligence. In the economic framework of liability, it is assumed that negligence is established by comparing the injurer's behavior to some pre-specified level of care, and the courts, or maybe lawmakers, set this level of care. In any case, whatever body establishes the non-negligent level of care, it is assumed that courts adhere to that standard of care in adjudicating negligence.

Table 2. The Negligence Rule: Care, Accident Risk, and Social Costs

Care Level	*Cost of Care*	*Accident Probability*	*Accident Loss*	*Expected Accident Loss*	*Liable for Loss*	*Private Cost*
None	$0	20%	$100	$20	Yes	$20
Moderate	$10	5%	$100	$0	No	$10
High	$15	3%	$100	$0	No	$15

Assume the court or legislature chooses the level of care that minimizes total social costs (as it should), which in our example is Moderate care. Table 2 summarizes the calculations of the injurer under a negligence rule with the legal standard of care set to Moderate. The difference between Table 2 and Table 1 is that if the injurer exercises at least Moderate care, it is not responsible for accident losses (as shown by the $0 in the "Expected Accident Loss" column of Table 2 for Moderate and High care). Thus, expected accident losses are zero to the injurer with Moderate or High care, and the victim must bear accident losses.

The injurer minimizes its private costs, which in this example requires the injurer to exercise Moderate care. As with strict liability, the injurer selects the optimal level of care (Moderate) under a negligence

rule. The injurer clearly would not choose a High level of care, since its private costs would rise to $15. Exercising a higher level of care is also socially undesirable, since it costs $5 to reduce expected accident losses by only $2 (5% to 3% probability reduction with a $100 loss).

4. *Findings*

With this simple example, we illustrated the standard theoretical result that both strict liability and a negligence rule result (theoretically) in socially optimal levels of care by the injurer in a unilateral accident scenario. Differences between the two liability regimes arise primarily in application. For example, under strict liability, courts need only determine the economic loss, whereas a negligence rule requires the court to determine both loss and the presence or absence of negligence. The latter determination may require the court to construct something like Table 1, where the costs and benefits of alternative levels of care are quantified. The negligence determination also likely incurs administrative costs and injects the possibility of error in legal judgments, as scholars arguing in favor of strict liability are wont to point out.[51]

This simple case (unilateral accident without activity) serves as the foundation for many claims about the application of strict liability for the software industry. We show later, however, that this most simple case can be a poor representation of the conditions that exist for many segments of the software industry.

5. *Technical Analysis*

The numerical examples above are a special case of a more general theoretical treatment of liability. To illustrate, we present in this section the simple mathematical analysis of liability in the unilateral case. We will not provide thorough theoretical treatments to all the scenarios we evaluate in this article, since we are simply demonstrating the generality of the theory as opposed to specific numerical examples. We present the mathematical treatment since its more general form allows for more flexibility in the analysis than do numerical examples. Nor do we mean to imply that this rudimentary technical treatment fully demonstrates the economic concepts of liability. Economic models of liability can be exceedingly complex, and alternative formulations may suggest conclusions deviating from those provided here. Nevertheless, we believe the general ("first order") concepts discussed in our analysis are substantially reliable and important components of any serious debate over software liability.

51. *See* Calabresi & Hirschoff, *supra* note 19.

For this simple case, assume that the injurer can choose a level of care c. The probability of an accident depends on care, so that the probability of accident is $p(c)$. If an accident occurs, then the harm is measured by h. The socially optimal level of care, c^*, is chosen to minimize:

$$c + p(c)h \; c + p(c)h. \tag{1}$$

Without liability, the injurer pays nothing for losses, so the injurer incurs only c; and to minimize private costs, the injurer chooses $c = 0$. With strict liability, the injurer incurs costs equal to $c + p(c)h$, so in this case the minimization of private costs is identical to the minimization of social costs. In this formulation, the injurer can be shown to choose c^*, the socially optimal level of care.

Under a negligence rule, the injurer pays accident losses only if $c < c^*$, assuming the court sets the non-negligent level of care to c^*. If the injurer chooses $c > c^*$, then the injurer incurs costs without any offsetting reduction in liability. Thus, it must be the case that $c \leq c^*$. Inspection indicates that $c = c^*$ is optimal.

B. Bilateral Accidents with No Activity

We now contemplate liability regimes when both injurer and victim can exercise care in order to reduce the accident probability. This bilateral accident scenario reveals the economic logic behind liability—that is, *liability should be assigned to the party that is in a position to economically control the risk of accidents (i.e., reduce accident costs at minimal expense)*. Again, we will employ numerical examples to illustrate the ability of alternate liability regimes to produce optimal outcomes.

Table 3 summarizes a numerical example for bilateral accidents. In the table, care costs are zero when no care is taken. If the injurer exercises care, then it costs him $3, whereas the cost is $2 for the victim to exercise care.

Table 3. Bilateral Accidents and Social Costs

Injurer Care Costs	*Victim Care Costs*	*Accident Probability*	*Accident Cost*	*Expected Accident Loss*	*Total Social Cost*
$0	$0	15%	$100	$15	$15
$0	$2	12%	$100	$12	$14
$3	$0	10%	$100	$10	$13
$3	$2	6%	$100	$6	$11

From Table 3, it is clear that it is socially desirable for both parties to exercise care in reducing accidents since such behavior minimizes to-

tal social costs (at $11). If, for example, the injurer exercises care but the victim does not do so, then the victim saves $2 in costs, but expected accident losses rise by $4. Thus, society prefers for the victim to exercise care since the social benefits of doing so exceed the costs. Similarly, if the victim exercises care but the injurer does not do so, then the injurer keeps $3 but expected accident losses rise by $6, so it is socially optimal for the victim to exercise care. Whether or not it is privately optimal for the injurer or injured to exercise care depends on the liability regime, which we turn to now.

1. *No Liability*

As before, in the absence of liability, the injurer will minimize its own care costs and, therefore, exercise no care (at a cost of $0). Since the injurer does not pay accident costs, there is no benefit to the injurer of reducing accident losses. The victim, however, bears the full accident loss, so the victim will choose to exercise care, reducing accident loss by $3 while incurring a care of cost of only $2. Since it is socially optimal for both parties to exercise care, a "no liability" regime does not render the optimal outcome, even though in this example the victim is led to exercise optimal care. In many real-world situations, however, the victim may exercise too much (or even too little) care in response to the lack of care by the injurer (and vice versa for the injurer under strict liability).

2. *Strict Liability*

Under strict liability, the injurer is liable for accident losses, so it has an incentive to exercise care. The injurer reduces its liability by $5 at a cost of only $3, so care is taken. The victim, however, is fully compensated by the injurer for any accident losses. Thus, the victim has no incentive to exercise care. While the victim could reduce accident costs by $4 at a private cost of only $2, the $4 expected accident loss is borne by the injurer, not by the injured. So, the victim does not exercise care. Since, in our example, social costs are minimized when both parties exercise care, *strict liability is not a socially optimal liability regime in bilateral accidents*. Put simply, strict liability is a "one sided" liability regime that is unable to induce optimal behavior in a bilateral context where both parties can economically reduce accident costs, and software failures can be bilateral in nature.

3. *Negligence Rule*

From Table 3 it is clear that it is socially desirable for the injurer to exercise care, since expected injury loss is always lower with care. Thus, in order to maximize the payoff, the standard of care for the injurer is also "care." (In this example, care is either exercised or it is not.) As

with the unilateral accidents, the injurer can escape liability for accident losses by exercising care, and therefore does so (incurring cost $3 to reduce expected liability costs by $5). By taking care, the injurer shifts the burden of accident losses to the victim. Since the victim can reduce expected accident losses by $4 at a cost of only $2, the victim likewise will exercise care, given that the injurer does so. Thus, both parties exercise the optimal level of care.[52] If the injurer does not exercise care, however, then neither does the victim, since all accident costs are born by the injurer if he fails to exercise care.

Unlike the unilateral case, strict liability and negligence do not render identical and optimal outcomes. As mentioned above, strict liability leads to too little care by the victim, since accident costs are borne by the injurer. Under negligence, however, both parties exercise care, which is the optimal outcome. Thus, in the case of bilateral accidents described here, strict liability and negligence are no longer "theoretically" fungible, and only negligence is optimal.

4. *Strict Liability with the Defense of Contributory Negligence*

As just described, strict liability will not induce victims to exercise care despite the fact that it is socially optimal for them to do so. It is possible to motivate the victim to exercise care under strict liability by adding the defense of contributory negligence to the strict liability standard. With contributory negligence, the injurer is strictly liable only if the victim exercised due care. If the victim does not exercise care, then the victim is negligent and bears its accident losses. Because failing to exercise care would cost the victim $4 in accident losses, which are avoidable for $2 in care costs, the victim will exercise care. The injurer also chooses to exercise care, because the liability costs are shifted back to the injurer when the victim exercises care. Thus, a regime of strict liability with contributory negligence induces the socially optimal level of care by both parties.

5. *Negligence Rule with the Defense of Contributory Negligence*

Under a negligence rule with the defense of contributory negligence, an injurer can escape liability even if he is negligent as long as the victim fails to exercise due care. Since the injurer bears accident losses if he fails to exercise care, the victim will exercise due care. By exercising care, the victim shifts accident costs back to the injurer. Thus, the injurer exercises due care. Therefore, under a negligence rule with con-

52. This logic applies likewise to the case of comparative negligence, where both parties fail to take due care. In this case, accident losses are shared by injurer and victim in proportion to the deviations from due care. If the court sets the level of care as due care, then optimal care is chosen by the parties.

tributory negligence, the social costs of accidents are minimized with both parties taking care. Because negligence alone was capable of rendering the optimal outcome, implying appending contributory negligence to a negligence rule is superfluous.

6. *Findings*

Unlike unilateral accidents, strict liability and negligence are not equivalent in bilateral accidents. Strict liability does not render the socially optimal levels of care since it fails to provide victims with a motive to exercise care. A negligence rule does lead to optimal care by both injurers and victims, if the standard of care is chosen to be the optimal level of care. But, appending contributory negligence to a strict liability regime results in the socially optimal levels of care by both injurer and victim. Optimal care is also taken under a negligence rule with contributory negligence.

As discussed in more detail later, the key insights from this discussion are the differences in the efficiency properties of strict liability in unilateral and bilateral accidents. This discussion clearly reveals that a well-designed liability regime should place liability on all parties who can economically control the risk of accidents.

7. *Technical Analysis*

When victims can exercise care, the social cost of accidents from Expression (1) is modified to be

$$c+ v + p(c,v)h \; c + v + p(c,v)h, \qquad (2)$$

where v is the victim's level of care. The optimal unique level of care is as (c^*, v^*) with both care levels being positive. Under a standard of no liability, the injurer will exercise no care, since the injurer cares only about minimizing c. The victim, however, incurs accident losses and thus minimizes $v + p(0, v)h$ by choosing $\hat{v}$, but care levels of $(0, \hat{v})$ have a higher social cost than optimal care levels (c^*, v^*). Similarly, under strict liability, victims exercise no care and care levels are $(c, 0)$. Under a negligence standard, injurers are liability-free when choosing c^*, so they ordinarily do so. Victims, then, minimize $v + p(c^*, v)h$, which is minimized by selecting care level v^*.

Under strict liability with the defense of contributory negligence, both parties choose the optimal levels of care. Victims choose the optimal level of care since they bear all accident losses if they do not choose the optimal level of care (as they do under no liability). If victims choose v^*, then injurers minimize $v + p(c, v^*)h$, which is minimized with care level c^*.

C. Unilateral Accidents with Various Activity Levels

In some cases, the probability of an accident is related to how often a person engages in a particular activity. For example, the probability of an accident rises (probably linearly) when the number of times someone parachutes out of airplane increases. For software, the probability of a virus attack increases when the number of times a person opens e-mail attachments rises.

Accordingly, it is very important to understand that a level of activity is different than a level of care. For example, the daredevil may pack his parachute with the same degree of care each time, but the probability of an accident still rises with each jump. Care describes the way something is done; whereas the activity level describes how many times that something is done. An ideal liability regime would not only induce the proper standard of care among the producer and consumer of a product, it would also induce the proper amount of use (activity) of that product. The activity level component of this analysis is particularly important with regard to products that carry an inherent level of risk but which still should be used in order to maximize social welfare. To illustrate, even the best designed hammer will injure some thumbs, and even the most secure remote PC access software will carry some security risks, but both hammers and remote PC access software have social value that should be accounted for in any liability regime.

Stated differently, when the level of activity is added to the model, the social goal is to maximize social welfare; whereas before, the goal was simply to minimize social cost. The difference in goals arises because the activity level increases the welfare (or utility) of the person taking action, and that increased utility must be compared against any costs caused by the activity. Table 4 provides a numerical example of a unilateral accident with activity levels.

Table 4. Unilateral Accidents with Activity

Activity Level of Injurer	*Total Utility*	*Total Costs of Care*	*Total Expected Accident Losses*	*Social Welfare*
0	$0	$0	$0	$0
1	$40	$3	$10	$27
2	$60	$6	$20	$34
3	$69	$9	$30	$30
4	$71	$12	$40	$19
5	$70	$15	$50	$5

In Table 4, we see that Total Utility rises with the level of activity (up to unit 5, at which point the marginal utility of the activity is nega-

tive). We assume that the cost of care rises linearly with activity (a very simple formulation where the level of care is constant and must be exercised with each unit of activity), and the probability-adjusted loss is $10 per unit of activity. Social welfare is computed as Total Utility less the Costs of Care and Expected Accident Losses (i.e., the benefits of the activity minus the costs of producing them). In our example, because the cost of activity is a constant $13 (care costs of $3 plus expected accident loss of $10), social welfare will rise as long as the change in Total Utility for an additional unit of activity level exceeds $13. As shown in Table 4, social welfare is maximized at $34 with 2 units of activity. In the second column, we see that utility rises only by $9 units with the third level of care, but the additional costs for that third unit equal $13. Thus, the third unit of activity should be avoided, at least from a social perspective.

Of course, the activity and care levels chosen depend on the liability regime. Assume, for now, that it is the injurer that engages in the activity (rather than the victim) in the unilateral case.

1. *No Liability*

Injurers bear no accident costs under a no liability regime. Thus, injurers fail to take care and engage in too much activity. In our example above, the injurer will select an activity level of 4, since the fifth unit has negative marginal utility. There is no incentive for the injurer to take care, and no incentive to stop activity as long as utility rises with additional activity. Obviously, social welfare is not maximized under "no liability."

2. *Strict Liability*

Under strict liability, injurers enjoy the benefits of activity but also bear the full social costs of that activity. Thus, injurer will choose social welfare maximizing, which will maximize the level of care ($3 per activity unit) and activity (2 units). As with unilateral accidents without activity, strict liability is optimal.

3. *Negligence Rule*

In the earlier example without an activity level, the negligence rule motivated the injurer to select the optimal level of care in unilateral accidents. Whether or not that happens (with activity) depends on the parameters of negligence. For example, if the standard of care includes only care and not activity, then the injurer can escape liability by choosing the optimal level of care. Since liability is unaffected by the activity level, the injurer selects an activity level that is too high (activity continues as long as total utility rises more than care costs with additional activity). Thus, a negligence rule that ignores activity leads to an ineffi-

cient result. In Table 4, this type of negligence rule leads to an activity level of 3 units (for the fourth unit, the utility is only 2 units and the cost of care is 3 units, so the fourth unit is not privately beneficial).

Alternately, if both care and activity are components of the negligence rule, and the optimal levels of both are chosen by the court, then the injurer selects to maximize social welfare, which in turn maximizes the levels of care and activity. Of course, there are likely to be practical limitations for a governing body in choosing both the socially optimal levels of care and activity.

4. *Findings*

In a unilateral accident in which activity level is a factor of our analysis, only strict liability induces the socially optimal levels of care and activity. The negligence rule fails to induce optimal activity if the rule only addresses the optimal level of care.

The practical difference between strict liability and negligence depends on the marginal contribution of activity to expected loss. If activity has little effect on expected accident losses, then the difference between the two regimes will be small, as optimal care is exercised in both regimes. In contrast, if activity substantially increases expected losses, strict liability will be the strongly preferred liability regime in unilateral accidents where the level of activity is relevant.

5. *Technical Analysis*

Adding activity to the model requires that we specify a benefit function. Let $b(a)$ be the benefit from activity level a. It is beneficial to maximize social welfare, which is:

$$b(a) - a(c + p(c)h)\ b(a) - a(c + p(c)h), \tag{3}$$

and the values a^* and c^* maximizes this function. Note that c^* minimizes $c + p(c)h$ regardless of a. The optimal level of a^* ensures

$$b'(a) = c^* + p(c^*)h\ b'(a) = c^* + p(c^*)h, \tag{4}$$

which is simply the typical marginal condition of maximization (the marginal benefit equals the marginal cost of activity, given c^*).[53]

In the absence of liability, the injurer simply maximizes $b(a)$, because all the costs of accidents are borne by the victim. With strict liability, the injurer pays all accident costs, which maximizes Expression (3), which is social welfare. Under a negligence rule (with only care specified), the injurer can be shown to choose a to maximize $b(a) - ac^*$, imply-

53. The term $b'(a)$ denotes the derivative of b with respect to a.

ing a satisfies $b'(a) = c^*$. The optimal level of a *(say* $\hat{a}$*)*, however, satisfies Expression (4). Thus, under a negligence rule (with only care specified), $\hat{a} > a^*$ (since b' is subject to diminishing marginal returns and $p(c^*)h$ is positive).

D. Bilateral Accidents with Activity Levels

With bilateral accidents, it is assumed that both the injurer and victim must engage in activity in order for an accident to occur. For both injurer and victim, increased activity (use of the product) increases utility, but that increased use also increases the opportunity for an accident.[54] The implications of alternative liability regimes in the bilateral accident are apparent from the unilateral accident with activity.

1. *No Liability*

Without liability, injurers have no incentive to exercise care or restrain activity. In contrast, victims incur accident costs. However, since victim optimal care and activity depends on the behavior of the injurer, victims may not exercise optimal care and activity (perhaps too little or too much). Similar to unilateral accidents, a no-liability regime does not render optimal outcomes.

2. *Strict Liability*

Under strict liability, the injurer bears all accident losses. Thus, the injurer maximizes its own benefits minus care costs and expected accident losses. Since the injurer bears all accident costs, the victim maximizes its own utility by choosing a high activity level and no care. Thus, the victim engages in an excessively high activity level and exercises too little care under strict liability.[55]

3. *Strict Liability with the Defense of Contributory Negligence*

Under strict liability with the defense of contributory negligence, victims can avoid self-funding accident losses by exercising due care. Thus, victims may exercise care, but continue to engage in an excessively high activity level since care alone frees the victim from funding accident

54. The difference between care and activity is important. Care, for example, reduces the probability of an accident from 10% to 5% for each unit of activity. Activity, alternatively, represents the number of times the victim or injurer engages in the activity, with each unit of action having a 5% probability of an accident (if care is exercised).

55. Lichtman & Posner, *supra* note 47, at 27. Lichtman and Posner provide an example often used by scholars to illustrate this point that relates to damages from noise and air pollution around airports. *Id.* "[C]onventional wisdom argues against holding airports strictly liable for pollution and noise externalities, the fear being that neighbors would then ignore these factors when deciding how best to use neighboring properties." *Id.*

losses. Thus, under the bilateral-activity model, strict liability with contributory negligence does not result in the social optimal level of activity.

4. *Negligence Rule*

As in the previous example, exercising due care allows the injurer to escape liability under a negligence rule. If the injurer exercises due care, then the victim bears all accident costs and will therefore exercise care, which will result in the socially optimal activity level. The injurer, however, will have too high an activity level, but the care and activity level of the victim will be optimal (since the victim bears accident losses).

5. *Findings*

In a bilateral accident in which activity levels are part of the analysis, there is no single socially optimal liability regime. The choice of regime depends on whether or not it is more important to control the activity level of the victim or the injurer. With strict liability, the victim's activity level is too high; with negligence, the injurer's activity level is too high (assuming activity is not specified in due care). As revealed by this discussion, in the bilateral accident with activity there are four "behaviors" to control: (1) injurer's care; (2) injurer's activity; (3) victim's care; and (4) victim's activity. None of the liability regimes, as typically construed, control all four behaviors. While it is possible that both care and activity enter the standard of care, the practical difficulties of establishing such a standard cannot be dismissed. More realistically, the liability regime should be selected based on the relative influence of activity on accident losses. In other words, lawmakers should ask and answer this question: whose activity level is more important to control, the victim's or injurer's?

6. *Technical Analysis*

Some of the ideas relevant to this section have already been discussed. However, the technical analysis of bilateral accidents with care can be very complex and include both "first-order" (as we have discussed above) and "second-order" effects (that is, behavior that is somewhat less obvious or intuitive). As for the first-order effects, as shown in Section III.B.7, if both parties can economically affect the probability of an accident, then both parties must face liability for an economically optimal outcome. Similarly, the role of activity on outcomes is detailed in Section III.C.5. Here we showed that the activity level of the injurer is too high if activity is not a component of the negligence standard. Since we ignored the role of care for the victim in this section, strict liability rendered the most optimal outcome. However, strict liability is not economically opti-

mal when the victim can reasonably reduce accident probability by exercising care, as shown in Section III.B.7.

For victims, the privately optimal level of activity will not generally be socially optimal in the bilateral case with activity. With no liability, the victim may be expected to engage in too much care, and likewise will ordinarily engage in too little activity, since the total lack of care by the injurer increases expected accident costs to the victim. Under strict liability, of course, the victim has no incentive other than maximizing private benefits, and thus will ordinarily take little care and engage in too much activity. This conclusion, however, should be carefully evaluated based on the circumstances of the specific case, because in suitably complex environments, the victim can nevertheless influence the injurer's behavior to some degree by its actions. Negligence rules are even more complex to evaluate under certain conditions. It is probably safe to say, though, that in most plausible environments, the "first-order" sorts of liability effects dominate so that agents with limited liability exposure produce suboptimal care and engage in too much activity.

In summary, the salient points of this analysis are relatively intuitive. Agents, either injurers or victims, should face liability rules that lead them to behave in a socially optimal fashion. That, in turn, ordinarily implies that when either the injurer or the victim can affect accident costs through their care and activity choices, both the injurer and the victim need to share in accident costs. When the liability rules are unable to include standards on activity levels, or when policy makers and the courts choose not to implement such rules, the resulting "second best" liability assignment will almost surely impose some liability on both parties, even when one party has a relatively small degree of control over accident risks.

IV. WHEN VICTIMS ARE CUSTOMERS, INJURERS ARE FIRMS

In the economic theory of liability, when victims are customers of firms, two things change. First, the analysis of liability regimes must include purchasing decisions. In essence, a customer's purchasing decision is based on the full price of the product, which includes the expected accident losses not covered by the seller (or injurer). Thus, including the purchasing decision in the analysis can dramatically alter the ranking of alternative liability regimes, since the care exercised by firms is reflected in the full price. Second, and related to the first, in the economic analysis of liability, when victims are consumers, risk preferences play a key role in the optimality liability regimes. Risk is important because the customer's estimate of the "full price" includes an assessment of the risk of accident and the size of the loss. If the customer cannot assess the accident risk prior to purchase, then the full price fails to include ex-

pected accident losses and firms cannot be differentiated on their level of care.

A. Customer's Knowledge of Risk is Perfect, Unilateral Accidents

If the customer knows exactly what the risk of a product is, then firms will take optimal care even without liability. This is because when a customer makes a purchase, the customer will consider the full price of products (or services), which includes the nominal price (the price paid at the register) plus the expectation of losses (and other transactions costs). Without care by the firm, the full price increases (nominal price constant) as expected accident losses increase. Thus, if a firm fails to exercise care, then the customer may purchase from another seller that does exercise care at a lower full price (though, at a higher market price). This process theoretically leads to optimal care by firms.

Table 5. Firms and Customers, No Liability

Care Level	*Production Costs*	*Cost of Care*	*Accident Probability*	*Accident Loss*	*Expected Accident Loss*	*Market Price*	*Full Price*
None	$10	$0	10%	$100	$20	$10	$20
Low	$10	$1	7%	$100	$7	$11	$18
Moderate	$10	$3	3%	$100	$3	$13	$16
High	$10	$5	2%	$100	$2	$15	$17

To illustrate, assume a perfectly competitive market so that prices equal production costs. Table 5 summarizes the incentive for firms to take optimal care absent liability. From the table, we see that production costs are $10. If the firm exercises care, then the costs are $1, $3, and $5 for Low, Moderate, or High care, respectively. In the absence of care, the probability of an accident loss of $100 is 10%, but the probability falls to 7% with Low care, 3% with Moderate care, and 2% with High care. While the nominal price of the firm not exercising care is only $10, the full price is $20. All the prices with care are lower, but the lowest price occurs with Moderate care. Moderate care is optimal, since increasing care to High costs $2 but reduces expected accident losses by only $1, and reducing care to Low saves the firm $2 but raises expected accident costs by $4. Since consumers make decisions based on full price, the firm that exercises care makes the sale. Thus, firms have the incentive to take optimal care.

Table 6. Firms and Customers, Negligence

Care Level	*Production Costs*	*Cost of Care*	*Accident Probability*	*Accident Loss*	*Expected Accident Loss*	*Market Price*	*Full Price*
None	$10	$0	10%	$100	$20	$20	$20
Low	$10	$1	7%	$100	$7	$18	$18
Moderate	$10	$3	3%	$100	$3	$13	$16
High	$10	$5	2%	$100	$2	$15	$17

As with no liability, firms will take optimal care under a negligence standard where the duty of care is defined to be the socially optimal level of care. While the application of liability does not affect care, it does alter market price. In this example, if the firm exercises at least Moderate care, then it bears none of the accident costs. The firm will not exercise High care since it is costly and provides no benefit to the firm. If the firm exercises only Low care, then the costs of the product include expected accident losses, so the full price equals the nominal price ($18 in this case). Exercising No Care requires a nominal price of $20, where again no units are sold, since $16 is the lowest full price.

If firms face strict liability (in the unilateral case), then the market price is equal to the full price, since firms bear all accident risks. Thus, with strict liability, or with strict liability with the defense of contributory negligence, firms exercise optimal care. So, in this scenario, while the liability regime does not alter the decisions of firms to exercise care, liability does alter market price.

B. Customer's Knowledge of Risk is Perfect, Bilateral Accidents

In the case of bilateral accidents, a negligence regime results in optimal care by both firms and its customers. In Table 8 below, we illustrate this fact. The full social costs are minimized at $19, with both parties exercising Moderate care ($3 for the firm, $2 for the firm's customer). Neither party has an incentive neither to increase nor to decrease care, since the costs of doing so is not worth the benefit. For example, if the firm increases care to High, then its costs rise by $4, but the expected accident losses only fall by $2. Thus, the incentives of the parties line up with the social goal of minimizing social costs.

Table 7. Firms and Customers, Negligence

Firm Care Costs	*Customer Care Costs*	*Production Costs*	*Accident Probability*	*Accident Loss*	*Expected Accident Loss*	*Market Price*	*Full Price*
$0	$0	$10	12%	$100	$12	$22	$22
$0	$2	$10	8%	$100	$8	$18	$20
$3	$0	$10	8%	$100	$8	$13	$21
$3	$2	$10	4%	$100	$4	$13	$19
$7	$0	$10	3%	$100	$3	$17	$20
$7	$2	$10	3%	$100	$3	$17	$22

Alternatively, in the case of strict liability, firms bear all accident costs (i.e., customers are fully compensated for losses). Consequently, in this example, customers have no motive to exercise care. As shown in Table 8, regardless of the level of care exercised by the firm, the customer will always prefer not to exercise care (the customer's full price is always $2 lower if the customer does not exercise care). As before, social costs are minimized when both parties exercise moderate care ($3, $2, with social cost $19), so strict liability is not optimal.

Table 8. Firms and Customers, Strict Liability

Firm Care Costs	*Customer Care Costs*	*Production Costs*	*Accident Probability*	*Expected Accident Loss*	*Market Price*	*Customer Full Price*	*Social Full Price*
$0	$0	$10	12%	$12	$22	$10	$22
$0	$2	$10	8%	$8	$18	$12	$20
$3	$0	$10	8%	$8	$21	$13	$21
$3	$2	$10	4%	$4	$17	$15	$19
$7	$0	$10	3%	$3	$20	$17	$20
$7	$2	$10	3%	$3	$20	$19	$22

In Table 9, we also illustrate the possible outcome that the firm exercises too much care in the absence of care by the customer. This inefficient outcome arises because the full price is lower when the firm exercises High care (spending $7, with price $20) than either Moderate care ($3, $21) or No care ($0, $22), assuming the customer exercises no care. In essence, the firm exercises too high a level of care as a substitute for the customer's care, which is absent.

Table 9. Firms and Customers, Strict Liability with Contributory Negligence

Firm Care Costs	*Customer Care Costs*	*Production Costs*	*Accident Probability*	*Expected Accident Loss*	*Market Price*	*Customer Full Price*	*Social Full Price*
$0	$0	$10	12%	$12	$10	$22	$22
$0	$2	$10	8%	$8	$18	$12	$20
$3	$0	$10	8%	$8	$13	$21	$21
$3	$2	$10	4%	$4	$17	$15	$19
$7	$0	$10	3%	$3	$17	$20	$20
$7	$2	$10	3%	$3	$20	$19	$22

As before, the problems with strict liability in the bilateral case can be overcome by appending contributory negligence to the regime. Now, if the customer fails to exercise care, then the consumer bears the accident loss because both the firm and the customer exercise optimal care ($3, $2, with social cost $19). The firm has no incentive to exercise a higher degree of care, since the cost is $7 but there are no positive benefits from doing so to the firm.

C. Customer's Knowledge of Risk is Imperfect

Thus far, it has been assumed that the customer's knowledge is perfect so that all consumers are able to accurately assess the risk of accidents and expected losses. If customers assume there is no risk to a product, then, of course, firms will not exercise care absent liability. Firms exercise care only when it alters favorably the full price of their product relative to rivals through a reduction in expected accident losses (and full price). If customers do not perceive any accident risks (accident probability is falsely assumed to be zero), then there is no benefit to exercising care. Thus, some form of liability may be efficient under such conditions.[56]

As for customers, their behavior is also impacted by their perception of risk. If customers underestimate risk and thus understate their full price of consumption, then they will engage in too much of an activity or fail to take adequate care. Overstating risk leads to the opposite result—too little activity and too much care. If customers have knowledge of what is expected to satisfy due care, the impact of imperfect knowledge can be offset using the defense of contributory negligence.

Inevitably, the customer's knowledge of risk is somewhat imperfect. Therefore, it is impossible to say whether customers consistently understate or overstate risks. In some cases, firms may develop a reputation over time for being accident prone. Attempts to alter that reputation

56. It may be that the cost of care exceeds the cost of information, so that liability on the firm is inefficient.

may be difficult if customers have long memories. It is also the case that commercial users probably operate with better information than do other customers, because their purchases are often larger and of a repeated nature. In any case, expectations matter in decisions about the need for and preference among liability regimes.

D. Firms that Have Market Power

In the examples above, we assumed that firms operate in a perfectly competitive environment, thus pricing their products at marginal cost. If firms have market power, then the incentive of firms to exercise care is unchanged. Theory indicates that even monopolists have the incentive to operate efficiently, and thus all that is required for the examples to hold is a firm with market power.[57]

But market power is not innocuous.[58] Firms with market power set prices above marginal costs. Thus, if care costs $3 per unit, then the market price will rise by more than $3. If expected accident losses are $10 and the firm operates under strict liability, then the market price will rise by more than $10. Under negligence, alternatively, the customer will bear accident losses under due care, so the price, and thus quantity, will be more aligned with the social optimum (since losses are not marked up).[59] Thus, a negligence standard may be preferred in the presence of market power.

V. SOFTWARE AND LIABILITY

As shown clearly in the preceding sections, the choice of an appropriate liability regime depends on a number of factors, including (1) the nature of accidents (unilateral or bilateral); (2) whether or not there is an activity level in consumption; and (3) whether or not the item is purchased directly by the injured party. All of these factors are relevant to liability for software and expose the fact that all software is not the same in terms of ideal liability regimes. Importantly, we have not exhausted

57. Foundations of Economic Analysis, *supra* note 48, at 222.

58. *See*, *e.g.*, A. Mitchell Polinsky & William P. Rogerson, *Products Liability, Consumer Misperceptions, and Market Power*, 14 Bell J. Econ. 581 (1983). This article compares alternative liability rules for allocating losses from defective products when consumers underestimate these losses and producers may have some market power. If producers do not have any market power, the rule of strict liability is first-best. If market power is sufficiently large, a negligence rule is preferable. And if market power is even larger, the rule of no liability may be preferred.

59. This argument is similar to levying environmental taxes on a polluting monopolist. While taxes on the output of polluting competitive firms leads to more socially optimal output, the polluting monopolist already has reduced output, so a pollution tax may reduce output well below the socially optimal level. *See* William J. Baumol & Wallace E. Oates, The Theory of Environmental Policy 80-81 (1988).

all possible determinants of optimal regimes, or all potential regimes (e.g., comparative negligence). Yet, it is clear from the analysis that selecting an optimal regime is neither easy nor universal across all software types.

A. Liability for Intrinsic Software

Liability for intrinsic software, such as software that flies airplanes or controls hospital equipment, is probably best evaluated in the unilateral framework. Certainly, a passenger on an airplane has no control over the software systems used by an airplane manufacturer and has no opportunity to alter the care of the firm by choosing a competitive seller. And the passenger of an airplane or patient at a hospital certainly has little influence over the airline's selection of a particular airplane manufacturer or the hospital's selection of a particular type of MRI machine. Indeed, the airline and hospital itself (the customer of the software company) may rarely be able to evaluate the software used by a firm to produce this type of product. As a result, neither the injured party nor the customer (the airline or hospital) are in a position to make a full price comparison that includes the risk of a catastrophic accident.

Unlike word processors, in many cases, intrinsic software errors can cause physical injury or even death.[60] For intrinsic software, then, liability regimes for third-party injury such as strict liability or negligence may be appropriate, with the choice depending on the presence or absence of activity levels and difficulties in establishing the standard of care.[61] This is the conclusion reached by legal scholars such as Clarke,[62] and, in light of the economic analysis of liability, this prescription for intrinsic software seems appropriate.

B. Liability for Extrinsic Software

Choosing an optimal liability regime for extrinsic software—such as browsers, e-mail programs, word processors, and so forth—is significantly more complex. First, extrinsic software generally falls in the bilateral accident category, since both firms and the purchasers and users of the software may reasonably exercise care. When software is purchased, it is almost always installed on a computer that already has numerous programs on it and a variety of hardware components, any or all

60. *See* Nancy Leveson & Clark Turner, *An Investigation of the Therac-25 Accidents*, 26 IEEE Computer 18 (1993). "[S]ome of the most widely cited software-related accidents in safety-critical systems involved a computerized radiation therapy machine called the Therac-25. Between June 1985 and January 1987, six known accidents involved massive overdoses by the Therac-25 — with resultant deaths and serious injuries." *Id.* at 18.

61. Clarke, *supra* note 4.

62. *Id.*

of which may interact either positively or negatively with the new software. Compatibility between software is often a desired feature, certainly between operating systems and applications, but this interoperability can create "holes" in the software for malicious code, conflicts leading to unpredictable calculation errors and other manifestations of incompatibilities. While a seller of software can advise the consumer of incompatibilities, only the consumer can act on that information (or the consumer is in the best position to act on that information). Further, in general, only the consumers can economically (and technically) ensure that all patches are installed in a timely fashion and that security software is installed and up-to-date. This is to be contrasted to certain mass-produced industrial goods—it would not generally be economical to have the consumer repair a faulty toaster that explodes due to the defect. Consumers of extrinsic software can also engage in other activities, like frequently downloading "shareware" or even browsing certain websites. This may pose a security risk and such activities are not in the software firm's control. Software that uses the Internet to operate efficiently may effectively require the user to keep separate antivirus software up-to-date, and the manufacturer of the software may have little or no input into what type of antivirus software is loaded or updated (or have uneconomically high costs of monitoring such activity).

As described in detail in the previous sections, in the case of bilateral accidents where both agents can economically control accident risks, strict liability is no longer optimal. With strict liability, the injurer bears all accident costs and as a result, the victim has no incentive to exercise care.[63] Under a negligence standard, however, both the injurer and victim have appropriate incentives to exercise care; by exercising optimal care the injurer can shift the burden of accident costs to the victim. The defect in strict liability can be remedied by adding the defense of contributory negligence, and this combination renders the socially optimal outcome. Determining which standard is better depends, in the end, on practical concerns, but the analysis suggests that any tort standard that does not induce the consumer to exercise care when economically possible renders non-optimal outcomes. Because accidents with extrinsic software are often bilateral in nature, any liability standard must induce

63. There is some evidence to suggest that it is the activity and care of the customer that is more important to avoiding accidents, at least of a security nature. A survey by the antivirus software company Sophos indicated that 64% of 200 IT professionals blamed the "customers" (network managers) and not Microsoft for the havoc resulting from the Slammer virus. The survey revealed that only 43% of system administrators had signed up for Microsoft's security vulnerability mailing list. Press Release, Sophos, System administrators blame each other for spread of Slammer internet worm, Sophos poll reveals (Jan. 27, 2003), *available at* http://www.sophos.com/pressoffice/news/articles/2003/01/va_slammer poll.html.

the user to exercise care (when efficient). A strict liability rule does not induce the user to exercise that care in the installation, operation, and use of extrinsic software.

Also, in many cases, for extrinsic software, activity level is an important dimension of liability.[64] For bilateral accidents, negligence and strict liability with contributory negligence have been identified as the only potential optimal regimes. If there are activity levels by both injurer and victim, then the analysis becomes more complicated. Under a negligence standard, the injurer exercises care, but the injurer engages in too much activity if the activity level is excluded from the standard of care. Since the victim bears accident costs, the victim exercises appropriate care and chooses the optimal activity level. Under strict liability with the defense of contributory negligence, the reverse is true. By exercising care, the victim shifts the burden of accident losses to the injurer and as a consequence engages in too much activity.

In the end, the choice of regime in bilateral accidents with activity depends on whose activity poses the greatest risk. As described by Shavell:

> Strict liability with the defense of contributory negligence will result in higher social welfare if its disadvantage—that victims engage too often in their activity—is not as important as the disadvantage of the negligence rules—that injurers engage too often in their activity.[65]

Thus, as a matter of policy, the relative risk of anticipated activity levels must be considered. What might be a socially optimal outcome for software with a relatively low activity level may be suboptimal for software that is used far more often (for which the least-cost means of avoiding accidents might simply be for the consumer to use the product less). Since the relative risks are unlikely to be identical for all types of extrinsic software, choosing a generic liability regime applicable to all forms of extrinsic software is precluded.

Further, because extrinsic software is usually purchased by the end-user customer, the need for strict liability or a basic negligence standard is questionable since firms have an incentive to exercise optimal care if

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64. There is some relevance to the difference in activity levels between software firms and its customers. Activity for the software firm is best characterized as the number of units sold. Obviously, as sales increase, the expected accident losses rise (though the probability may be constant). On the consumer side, it is the use of the software that constitutes activity, including the failure to install patches, the failure to frequently update antivirus definitions, the uncritical opening of e-mail attachments, and so forth. To a large extent, the risk of a software-related "security" accident seems more likely related to the customer's behavior than merely the sale of additional units. If so, then controlling the activity of the customer is more important to approaching an optimal outcome. Of course, the customer's activity may play no role in accidents in some cases (as a result, the liability regime need not control the activity level of software users).

65. FOUNDATIONS OF ECONOMIC ANALYSIS, *supra* note 48, at 202.

the users have a sound knowledge of product risks. In more competitive software markets, users can clearly choose among software packages offering the lowest full price. Information on the relative performance of software is generally good, since the Internet provides ready access to professional and consumer reviews of nearly all software available for purchase for free.

Finally, accidents for extrinsic software are typically economic in nature (e.g., data destroying viruses, capacity hogging worms, and so forth), and the courts have not traditionally considered economic losses to be an issue of tort liability. Nevertheless, suffering only economic losses does not preclude a successful liability claim, so some attention to appropriate liability regimes is perhaps prudent.

VI. CONCLUSION

As discussed above, a significant (but not exclusive) contributor to the evolution of product liability law is a concern for economic efficiency—liability law seeks to maximize social welfare by inducing levels of care by firms and consumers so that accidents and harms from products that could be efficiently avoided are indeed avoided. Unfortunately, responsibility for accidents or failures of a product often takes on a moral tone that overshadows this economic efficiency rationale. Strict liability rules were designed to apply to particular manufactured products not out of a sense of retribution but with this efficiency goal in mind, based on a judgment that the producer of a defective mass-manufactured product, with which the consumer had little or no ability to alter (the proverbial "exploding toaster"), was in the best position to understand the probability of an accident occurring and balance that against the cost of changing that probability by exercising more or less care. This article shows that blindly applying strict liability to software, as several commentators have proposed, could be a mistake because not all types of software share the characteristics of mass-produced goods for which the strict liability rule was developed.

While liability is a complex issue and no single treatment of the issue is exhaustive, this article reviews the basic economic theory of liability and examines how computer software may fit into that framework. After review, it becomes apparent that while an argument can be made for a strict liability or negligence standard for certain types of "intrinsic" software, such regimes are unlikely to be optimal for "extrinsic" software, given the significant involvement of the consumer in the selection, operation, and maintenance of that type of software. Moreover, since the relative risks are unlikely to be identical given the myriad of software available to perform a wide variety of tasks, choosing a generic liability regime applicable to all forms of extrinsic software is ill-advised.

To maximize social welfare, a nuanced approach to liability should induce consumers to exercise a degree of care in the installation, operation, and use of extrinsic software.