Imperfect Commodities, Tort and Contract Law: An alternative to the precaution model in law and economics

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I. Introduction

The model of precaution has become a central tool for the economic analysis of the law, beginning with Judge Learned Hand's brilliant opinion in United States v. Carroll Towing Co. (1947). In it he argues that a defendant should be found liable for a harm if and only if the expected cost of additional care is less than the expected benefit.

The economics used in the model of precaution relies upon the economics of incentives, which can be viewed as a subfield of game theory – the study of how individuals choose actions when these actions affect others. The landmark books of Landes and Posner [1987] and Shavell [1987] illustrate how the precaution model can be used to understand a wide variety of legal rules. Calabresi and Malamed [1972] show how it can be used to integrate tort and property. Cooter [1985] uses the model of precaution to provide a unified analysis of tort and contract.

The purpose of this paper is to briefly outline an alternative approach that relies upon ideas that were developed in the 1950s by Herbert Simon, Leonard Savage, Kenneth Arrow and Gerard Debreu. These ideas were expressed in abstract mathematical terms that were not accessible to a wider audience, as reflected in the comments of Calabresi [1961], who wrote at the time:

Another, and perhaps more significant, problem which we confront is that

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the article must deal in theory—often, unfortunately, in that most dismal of theories, economics. Hopefully, it will do so in terms which are intelligible to law teachers, if not to lawyers, and without that suicidal desire of the economist to make his theory so pervasive and detailed that it is rendered utterly useless to the lawyer who lives in the world of men, and even to the law teacher, wherever he lives.3

It took many years for these ideas to become fully integrated into mainstream economics. They are now taught to all first year economics students using the de facto standard textbook by MasCollel, Whinston and Green [1995].4 Savage's ideas were integrated into modern game theory by Kreps and Wilson [1982], and later applied to the law in Baird and Gertner [1994].

The precise notion of a commodity was first outlined clearly by Debreu [1959]. However, his book is typically cited for the lucid development of the two welfare theorems of general equilibrium theory. The welfare theorems were later popularized by Friedman [1962] to become two of the arguments used in favor of free markets. Yet, strictly speaking the welfare theorems could not be applied to observed economies because markets are very incomplete. Friedman recognized this, but using the kind of analogical argument that is common in legal scholarship, he argued that in a free economy markets would become more complete, and hence more efficient over time.

However, in his Ph.D. thesis, Hart [1975] showed that adding more markets could in fact lead to less efficient outcomes. That line of thinking led to a body of work that integrates the legal notion of property into the theory of the firm. The result is what we now call the property rights approach to the theory of the firm (see Hart [1995]). In this paper we show how these ideas can be extended to some issues in contract and tort law. Specifically, we show that thinking in terms of commodities rather than precaution leads to a common perspective that can address a number of troubling doctrines in law.

Specifically, we show that it is consistent with the limits on liability for unforeseen events established in the case of Hadley v. Baxendale [1854]. Next, we show that strictly liability and the negligence rule in tort law can both be viewed as implied contracts where liability is equivalent to a breach of duty to supply a commodity of a particular quality.

Finally, we discuss the empirical relevance of the model of precaution and how we currently approach this problem in economics. There is extensive evidence, both from field data and experimental data that individuals adjust their behavior in the face of rewards and punishments. However, as Gary Schwartz [1994] observes, many legal scholars have observed that the model is not sufficient to explain the structure of observed law. Craswell [2000] points out that one of the roles of theory is to help organize doctrine, yet he is not convinced that the categories used in law and economics for organizing contract law are useful. Posner [2003] also argued that current law and economic analysis has made a slight contribution to understanding the law.

One reason for this is that the law is deeply empirical – law is created and modified based upon real events in peoples lives. Real life is messy, and teasing out the link between intent and consequence is very difficult. The imperfect commodities approach provides an explanation of why things are messy, but it cannot by itself address the empirical issue of how the law affects observed behavior. The model

3 Page 499.
4 Though see Kornhauser [1976] (well ahead of the times) for an application of these ideas to the problem of standard form contracts, page 1167-68.
of precaution is often used to argue for particular rule changes under the assumption that individuals will respond as predicted by the theory. Steven Kerr's [1975] classic article, *On the Folly of Rewarding A, While Hoping for B*, provides a wealth of examples in which businesses use the model of precaution to design incentive systems, only to find that they resulted in unanticipated and dysfunctional behavior.

The point is not that individuals do not respond to incentives, but that in a world with imperfectly described commodities it is impossible to consistently predict behavior. Economics has taken this point on board, and just as economic theory has become increasingly complex (reflecting the complexity in the actual environment), empirical work has become increasingly less complex. Recent books such as *Feakonomics* by Levitt and Dubner [2006] and *Poor Economics* by Banerjee and Duflo [2011] have introduced to the broader public a set of experimental and quasi-experimental techniques that can be used to measure the causal impact of an effect. In the final section of the article we discuss these trends and how they can be used to provide a more useful economic approach to the law.

II. The Notion of a Commodity

At the core of first year micro-economics is general equilibrium theory and the two welfare theorems that were developed in the 1950s by Arrow, Debreu and MacKenzie. General equilibrium theory, brilliantly exposited in Gerard Debreu's classic, *Theory of Value*, provides a model of an idealized (utopian) world with scarce resources, where individuals care about how these resources are allocated. What is possibly not well appreciated outside of economics is that this model provides a very general way to think about the world. Any failures to achieve an efficient outcome can be viewed as a failure of the environment to satisfy the axioms of general equilibrium theory.

Conceptually, this means that the theory provides a benchmark against which one can evaluate any allocation of resources among individuals who value these resources. One may wonder how this is possible - the answer lies in chapters 2 and 7 of Debreu's thin book.

Debreu introduces a notion of a "commodity" that generalizes our notion of a good or service. In particular, when we speak of the price of wheat or the wage of a worker, these are not well commodities in Debreu's model. The reason is that a good becomes a commodity only when the characteristics of the good are precisely specified (the quality of the wheat for example), as well as the date and location at which the good is traded. Similarly, labor services become a commodity when the characteristics of the service (was the waiter friendly, did the lawyer prepare the brief correctly) are precisely specified, as well as the time and the delivery location of the service.

The next step in general equilibrium theory is to suppose that markets are "complete," i.e. one can trade any commodity. The first welfare theorem states that at a competitive equilibrium – each person chooses the bundle of goods they prefer and supply equals demand – the allocation must be Pareto efficient. Any change to the competitive equilibrium will make some party strictly worst off.

In the context of the model of precaution the assumption that markets are complete would require that for every action chosen by the individual there would be a different good and different price. As Becker [1976] observes, the notion of price used here is not the same as the notion of price in law. In the
Second welfare theorem price is a measure of the opportunity cost of the good – technically it is the Lagrange multiplier associated with the aggregate resource constraint. Economists will talk of the price of the good even when it is not traded. By this they really mean the marginal value of the resource constraint. This concept is very useful when evaluating the efficiency property of an allocation, but can be confusing since it may not correspond to an observed price.

Price in law defines the terms of trade for a good exchanged between two parties – the amount that the seller agrees to pay the buyer for a good, rather than the shadow value of a good. If the good delivered is not satisfactory or the buyer does not pay then there is breach of contract. In that case Holmes [1897], page 462 observes:

“The duty to keep a contract at common law means a prediction that you must pay damages if you do not keep it--and nothing else.”

In other words, if the seller chooses a quantity or quality different from the agreement, then the amount she receives will be reduced, normally using the rule of expectation damages.

In order to distinguish the two notions without adding too much jargon, we call the former a “contract price” and the later an “economic price.” We can see the difference with a simple example. Suppose that the seller chooses to deliver or not, and agrees to pay damages for non-delivery. In this case there are two economic prices corresponding to each of the two commodities – the price that is paid when delivery occurs and the price that is paid when delivery does not occur.

The law in this case is quite a bit more subtle than the economic analysis. In particular, the law distinguishes between several contract forms. One is a two part tariff in which the seller can choose to deliver or not, and then is paid the corresponding price (say penalty k when there is no delivery). The second is a specific liquidation damage clause requiring k be paid in the event of non-delivery.

In the first case non-delivery is not breach of contract – only non-payment is a breach. In contrast, in the second case non-delivery is a breach of contract. In the former case, as long as the seller pays the penalty, then there is no breach of contract and the buyer has no right to bring an action against the seller. In the second case, the buyer has the right to bring the seller to court. Even if the seller voluntarily pays the stipulated damages, the buyer has the right to have a court review the dispute, a right that is denied in the first case. In a world of real transaction costs, where going to court is costly, these contracts are not the same.

Finally, there is the “fixed price” contract in which the parties agree to a price and quantity/quality of the good to be traded, with no other terms. In this case the event of non-delivery leads to a breach of contract, which in turn gives the buyer the right to a hearing in court. There the court will determine damages.

It is common for scholars (both economics and legal scholars) to claim that fixed price contracts are the norm for many sales contracts, and this is a puzzle for economics because the theory predicts different prices in different states of the world. The fact of the matter is that since breach leads to a different allocation from that which would occur without breach, the contract price may be fixed, but the economic price is not.\footnote{For example, Posner [2003] states in his discussion of the economic theory of contract: “The contracts that the models predict do not exist in the world. Instead, we see simple fixed price contracts or contracts that are conditional on a}
Over time we can expect contract prices to become more like economic prices. Consider for example the famous case of Hadley v. Baxendale [1859]. In this case the Hadley brothers were millers who sued Baxendale for damages due to the slow delivery of a part for their mill that needed repair. At the time delivery speed could in principle be contractually specified. The model of precaution would predict that a penalty for slow delivery would be needed to encourage the carrier to act with haste. These days rather than have the carrier choose different delivery speeds as a function of the incentives he faces, each delivery speed is priced differently. For example, FedEx offers both a next day delivery and a 3 day delivery, each with a different price.

Thus, rather than have the miller design a contract to provide appropriate “incentives,” modern delivery companies offer different commodities corresponding to different delivery speeds. We return to rule developed in the case of Hadley v. Baxendale limiting liability arising from consequential damages in section IV.

Another example of the creation of new commodities is the development of norms for production and exchange of cotton. Bernstein [2001] describes in some detail the historical evolution of the private law regarding cotton. She does not explicitly link this development to Debreu's model, but one can view the development of “bright line rules” as the creation of well defined quality standards for cotton.6 Once different quality standards have been specified, then cotton can be traded upon an open market with different quality goods fetching different prices.

The next issue is how to address uncertainty within the context of the commodity model. This issue is explicitly addressed in chapter 7 of Debreu [1959]. This chapter builds upon the mathematician's model of uncertainty. That model begins with the hypothesis that one can in principle describe all possible world histories (called states), which include all potential future events in the world. In this model learning can be viewed like the fog lifting. As time moves on we can see that some histories (states of the world) did not occur, and we are left with fewer and fewer possibilities, until time fully unfolds and we are left with a single state representing all that can be known. An event in this model is a set of possible states. For example the event that it rains today means that all states in which it did not rain have not occurred.

The notion of a commodity is extended to uncertainty by allowing it to be state/event contingent. One way to see how this works is to consider house insurance. It is a commodity that pays the buyer an amount L if and only if the house burns down. There are many different possible insurance contracts – one could have a fixed amount L, or one might buy a contract that pays L(s), the full loss when a fire of severity s occurs. Such contracts can be bought and sold in a market.

There are two points worth highlighting here. First, it is common for parties to a bargain to think in terms of moving the burden of a loss in a state to one party or the other. Calabresi [1961]'s seminal article explicitly addresses this issue in detail and discusses the various meanings that have been attached to risk sharing. The notion of a commodity illustrates that risk is like any other characteristic of a good. The allocation of risk across states is an issue of personal preference and individuals will differ in their valuation of different allocations of risk.

The second, more subtle point is that the definition of uncertainty does not require a theory of relatively small number of real world contingencies. Intuitively, the problem with the predicted contracts is that they are too complex for parties to design.”

6 Page 1731.
probability! Once the payoffs have been defined for each state, then parties can trade and agree to state contingent prices with absolutely no reference to probability! Given that probability is central to the theory of precaution beginning with Learned Hand's rule for negligence, one may wonder how it enters the theory. We address this issue in the next section.

III. Decision

In this section we briefly outline the Savage (1954) model of choice. Except for one minor cite by Shavell [2004] we could find no discussion of the model in the law and economics literature. This is unfortunate because in addition to providing the model of rational choice that is now used in economics, Savage's work clearly illustrates why the model of precaution, while useful, is not likely to be a very good model of actual choice. The way Shavell cites Savage is an accurate description of how he is commonly used. However, if one reads the original text it is quite clear that Savage views rational choice as a complex, multi-stage process that is very much in line with recent work in behavioral economics.

In this section we provide an intuitive introduction to the Savage model, and then discuss its implications for behavioral economics and the model of precaution.

The Savage Algorithm

The Savage algorithm for rational choice follows a number of steps. In the first step, a decision maker builds a “small world model”. This is not a true model, but a simplification of the real world. He uses the standard model of uncertainty discussed above, but recognizes that it is impossible to contemplate all possible states of the world. He states “This is utterly ridiculous … because the task implied in making such a decision is not remotely resembled by human possibility”. Thus, he asks the decision-maker to construct possible states of the world that are relevant for the decision at hand. Later, in section 5.5, he provides conditions under which this small world model is consistent with the large world. He explicitly uses a version of the notion of commodity we discussed above to describe individuals’ choices.

He calls each choice an “act.” By this he is explicitly recognizing that choices have uncertain consequences. Thus, the decision to bring an umbrella to work has a number of uncertain outcomes – the umbrella may be lost or the decision-maker may use it when it rains, and thereby keep dry. Conversely, the “act” not to bring the umbrella to work ensures that it is safe at home, but then the person may become wet when it rains.

In the famous case of US vs Carroll Towing the barge broke loose from its moorings and caused an accident. The decision in question was how to adjust the mooring lines, with the relevant event being

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7 Page 596, footnote 3 states: “That a person's prospective evaluation of an uncertain event can be expressed as a probability-discounted sum of utilities....and it can be proved under very weak assumptions (see in particular Savage 1972), but these assumptions need not detain us here.”

8 See Chapter 6 of Mas-Collell et al. [1995].

9 Page 16.
whether or not the barge will break loose, and if it breaks loose what will occur. In this case the “acts” correspond to different arrangements of the mooring lines, and whether or not there should be a crew member on board for the night.

Observe that rational choice does not require that agents form probabilities. What Savage shows is that if choice satisfies a number of conditions the individuals will act as if they have formed a probability that there would be an accident. This was a very important development for the theory of rational choice because it showed that we can have a theory of probability based upon subjective beliefs. In many situations individuals (such as judges!) have to decide what to do, even though they do not have a clear idea of the likely consequences of their actions. Savage showed that one can be rational, even though objective probabilities do not exist.

The model that Learned Hand used to decide whether or not one should take more care with the barge moorings was a perfectly fine model to use. However, what we learn from Savage is that there are many models that one could build. Moreover, since the probabilities are subjective there is no reason why the person in this case should be using the correct probability. We now turn to discussing the implications of these models for the law.

**IV. Applications to Legal Rule Making**

In this section we discuss the application of these ideas to a number of legal issues. First, we discuss the implications for limitations on liability for unforeseen events. Next, the commodity model is used to provide a unified approach to the issue of negligence versus strict liability. Finally, we discuss how to use evidence to ask the relevant counter-factual questions – what are the actual consequences of a legal rule upon behavior as opposed to the hoped for consequences.

**A Construction Contracts, Expectation Damages and Hadley v. Baxendale**

In the well know case of Hadley v. Baxendale the English court ruled that damages that were unforeseeable at the time of contract did not give rise to legal liability in the event of contract breach. In this case the millers (Hadley brothers) had shipped a crankshaft to a firm to have a new one forged. The shipment was delayed and as a consequence the miller sued for lost profits. The court effectively ruled against the millers by stating that the lost profits were not foreseen at the time of contract.

One of the influential law and economics discussions of this rule is Ayres and Gertner [1989]. Their idea is that Hadley v. Baxendale is a penalty default rule. By this they mean that a buyer for whom the cost of breach is higher than can be foreseen is penalized by not revealing this information to the seller. They make the case in the context of a very clever model in which the prospective buyer does not wish to reveal information because of the fear that it will increase the transaction price.

Here they are using a “game theoretic,” rather than “general equilibrium” approach to the problem.\(^{10}\) They explicitly build on Savage's approach and first build a “small model” of the environment they are

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\(^{10}\) See Baird and Gertner [1994] for a comprehensive review of how game theory can be used in the law.
studying. Next they work out the sequential equilibria for their model. This approach to law and economics was first introduced by Brown [1973] in the context of tort law, and has subsequently become a standard tool in law and economics. The difficulty with game theory, as has become increasingly recognized in the profession, is that the models are very specific and difficult to generalize to a wide variety of situations. There is little evidence to suggest that they can be reliably used to predict behavior, particularly when there is asymmetric information.

From the perspective of the individual, game theory is a very useful normative theory that extends Savage's theory of rational choice to multi-person environments. The problem is given that we typically cannot observe the fine details of the game that individuals are playing it is difficult to make clear predictions – small changes to the information structure result in large changes in behavior. An implication is that one can rationalize a wide variety of phenomena with rational choice by adding features that are unobserved by either the courts or third party researchers. However, this does not imply that one can reliably predict behavior, an issue we discuss in detail below.

What we can say is that anybody who contemplates making a decision must spend time doing so. Bajari and Tadelis [2001] use this idea to view the first stage in Savage's algorithm as an investment activity. Chakravarty and MacLeod [2009] then use this idea to understand the observed form of construction contracts, such as those published by the American Institute of Architects (AIA). In particular, they show that these contracts are consistent with the legal rule of expectation damages and the limits on liability under Hadley v. Baxendale. Nevertheless, they show that the contracts achieve an efficient allocation under a wide variety of circumstances. Given that construction contracts been developed over a period of thousands of years going back at least to the Ten Books on Architecture by Ventruvius, the noted Roman Architect, they should have evolved to a relatively efficient form.

A construction contracts is akin to forming a small that has a limited lifespan (until the project is completed). The contracts regulate the allocation of relationship specific rents in a way that enhances the value of the project. The brilliant insight of Bajari and Tadelis [2001] is that one of these rents is the result of investment into planning. The sponsor of a building project reduces uncertainty by hiring an architect who prepares plans for a project. The amount of time and energy put in at the design phase affects the extent to which the building is a well defined “commodity.” They observe that the number of problems that one will have to address after construction begins fall with investment into planning. For example, until a project begins one may not know how much concrete will be needed for a foundation. Rather than ask the contractor to post a fixed price, the parties can agree in advance how much will be paid for the concrete per cubic foot.

In this way, Bajari and Tadelis [2002] are explicitly modelling the first step in Savage's rational choice model as an investment activity. They use an elemental model of contract price to motivate this idea. Chakravarty and MacLeod [2009] build upon their idea to construct a richer contract model that captures many of the salient features of the AIA form contracts. In particular, construction contracts have an explicit system for allocating decision rights between the sponsor and the contractor after construction begins. The allocation of these rights is efficiently enforced with the standard default rule of expectation damages and a generalization of the Hadley v. Baxendale rule.

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11 A sequential equilibrium is the game theoretic analogue to Savage's model developed by Kreps and Wilson [1982]
12 This example was provided by attorneys specializing in construction contracts.
We can illustrate the main result with a simple example. Suppose one views a project as consisting of a set of ingredients or components (the bricks, mortar, flooring, etc). Consider a single component, say the type of pipe to be used (as in Jacob and Youngs v. Kent (1921)). Let us suppose that the pipe can be one of two types, given by $d = 0$ or $1$, where as a matter of convention $d = 0$ is the default. Conceptually, $d = 1$ corresponds to a large number of alternative designs – we do not specify these in detail, rather we use a reduced form model in which we are concerned with the probability that there is a design change.

When putting the contract out for bid, the sponsor of the project can invest in design that in essence ensures that the specifications will not change. Let $p > 1/2$ be the probability that the design is $d = 0$, and $1 - p$ the probability that the design $d = 1$ is preferred $ex$ $post$. Barjari and Tadelis [2002] model this as an $ex$ $ante$ investment by the sponsor – the closer $p$ is to 1 the more complete the contract. The economic reason for a contract design is that if the contractor knows that $d = 0$ is the preferred design then he can make some investments into cost reduction.

Let $u(0,0)$ be the utility gain to the sponsor if $d = 0$ and this is the preferred outcome. Let $u(1,0)$ be the outcome from $d = 1$ when $d = 0$ is preferred. Similarly let $u(1,1)$ be the outcome when $d = 1$ is preferred and carried out, and similarly for $u(0,1)$. For simplicity we let $u^1 = u(0,0) = u(1,1)$ be the payoff when the sponsor gets her preferred design, and let $u^0 = u(0,1) = u(1,0) = u^1 - D$ when she does not get her preferred design. The value of $D > 0$ is the damages she would suffer when her preferred design is not implemented.

Whether or not a design change occurs depends upon the cost. Again for simplicity suppose there are two cost levels, $c_H > c_L > 0$. If the costs for $d = 0$ are low, then suppose that the costs for $d = 1$ are high and vice versa. The probability that the cost of design $d = 0$ is low is given by $e$, where $1 > e > 1/2$. It is assumed that the cost of $e = 1/2$ is zero and thus when the contractor makes no effort either design element could be low cost. This probability is viewed as a specific investment by the contractor made at a cost $C(e)$, were $C(1/2) = 0$ and $C', C'' > 0$. The contractor chooses his specific investment after the contract is signed and it is assumed that this is not contractible. It represents a reliance expenditure by the contractor.

There are two possible cases. One is what Chakravarty and MacLeod [2009] call the buyer biased case – namely $D > c_H - c_L$. In that case it is always efficient to change the project design when the sponsor has a preference shock and wishes a design change. The AIA contracts explicitly address this issue with the use of a change order – a legal instrument that allows the sponsor to unilaterally change the specifications of the project and not be in breach of contract. The only obligation is that she compensate the contractor for any increase in costs.

The case in which $D < c_H - c_L$ is more complex. Chakravarty and MacLeod [2009] call this the seller biased case. In this situation it is always efficient to carry out the low cost option. We have in mind situations like Jacobs and Youngs v Kent, where the design specified a brand of pipe, but the contractor substituted an equivalent quality because the intended brand was not available. One view of this case is that the sponsor simply wanted pipes that were of a given quality for the delivery of water in the house. The precise location of the pipes behind the wall, and the brand were not relevant to the purpose.
Under AIA contracts design elements that are not relevant to the final purpose of the project, but have different costs are normally under the control of the contractor. Before considering the various legal rules that might achieve this intent, we derive the optimal allocation. In the seller biased case it is always efficient to do the low cost design regardless of the preferences of the buyer, and hence the ex post cost is always $c_L$. Total welfare depends upon the probability that the sponsor gets her preferred design:

$$\text{Welfare} = p(eu^1 + (1 - e)u^0) + (1 - p)(eu^0 + (1 - e)u^1) - c_L - C(e).$$

This simplifies to the following expression, where $D = u^1 - u^0$:

$$\text{Welfare} = u^1 - pD + e(2p - 1)D - c_L - C(e).$$

Thus the optimal level of cost reducing investment by the contractor, denoted by $e^*$ solves:

$$C'(e^*) = F \times D,$$

where $D$ is the damage suffered by the sponsor when her most preferred design is not implemented and $F = (2p - 1)$ is a number that is between 0 and 1. This expression represents the extent to which the design is foreseeable. When the sponsor is not sure about the design, then $p = \frac{1}{2}$ and $F = 0$. In that case the contractor makes no specific cost reducing investment and $e^* = \frac{1}{2}$.

If the planning is very good, or in other words $d = 0$ for sure, then $F = 1$ and the contractor is fully liable for any changes he might make. Consider now the possible legal rules and their implication for the efficiency of the project.

Consider first a liquidated damage clause. In that case, the sponsor would specify in advance $D$ that would be paid if and only if the contractor deviates from $d = 0$. The contractor thus chooses investment to satisfy:

$$C'(e^{LD}) = D.$$

When $D$ is less than the benefit to switching to the low cost design, then we always get the contractor selecting the efficient project ex post, but if planning is incomplete and $F < 1$, then we get overinvestment ($e^{LD} > e^*$) by the contractor. A contractor that anticipates this over-investment will bid a higher price to compensate for the additional investment into cost reduction, leading to an overall increase in costs relative to the first best.

A second rule would cover the case in which the changes are so minor that they do not affect the overall value of the project. This was the ruling in the case of Jacobs and Youngs v. Kent – the desired pipes were judged to be of nearly equivalent quality to the ones installed, and hence no damages were

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13 This result is different from Rogerson [1984] who gets over-investment under the reliance rule, where it is the buyer and not the seller who is breaching the contract.
due. In this case the courts award damages of $D' = 0 < D$, and we get *under-investment* into reliance. This rule lowers the cost of the project, but also the quality from the perspective of the buyer.

The AIA contracts have a clause for precisely such cases that in essence allows for the deviation, but requires the contractor to adjust the price. This rule is equivalent to the standard legal rule of *expectation damages*. It requires that the sponsor provide evidence of damages she has suffered. In this example, the contract stipulates that design is $d = 0$ and hence if the sponsor prefers $d = 1$, and the contractor supplies $d = 0$, she cannot recover damages.

Therefore, damages can only be awarded in the case that the contractor supplies $d = 1$ and she prefers $d = 0$. In this case the *ex ante* expected damages that the contractor would pay is $p(1-e)D$. In this case the contractor will choose investment to satisfy:

$$C'(e^{AIA}) = p \times D.$$ 

The level of reliance is still greater than the efficient level, but lower than in the stipulated damages case.

This result illustrates that where there is uncertainty in design – namely unforeseeable changes - then the rule of expectation damages leads to over-reliance, but less over-reliance than with a stipulated damage rule or a specific performance rule.

This result has a number of implications. First, it helps explain why courts do not in general use specific performance, nor do they always enforce stipulated damages. Second, it shows that when there are unforeseeable events expectation damages can lead to over-reliance. Thus, a rough and ready rule that allows complete excuse from paying damages if the harm is small (Jacobs and Youngs v. Kent) or the event is unforeseeable (Hadley v. Baxendale) would adjust the strict expectation damages rules in the direction of a more efficient rule.

In the original case of Hadley v. Baxendale it was arguably the case that faster shipment by rail was the efficient rule, and hence the actions of the shipper were not efficient *ex post*. The market has evolved a number of solutions to this problem.

First, in the case of construction contracts when one is in a buyer biased case then the contract explicitly allows for the buyer to *unilaterally* change the design from $d = 0$ to $d = 1$ after the contract has been signed, even if the change is unanticipated. However, in doing do the contract requires the buyer to compensate the seller for any increase in costs. This rule avoids the seller holding up the buyer over design changes, while ensuring that the best project is chosen *ex post*. Chakarvarty and MacLeod [2009] show that this rule results in parties choosing efficient relationship specific investments.

Second, the Hadley v Baxendale rule has the potential to reduce damages towards the efficient level in a world with unforeseeable events. This rule has also been cited as one that encouraged industrial development (see Danzig [1975]). It can be explained in the context of the Savage [1954] model. In general for a state to be salient it must reach some perceptual threshold (see Pashler [1998]). The rule
of strict expectation damages might lead to some over-reliance, but it also has the feature that the seller pays damages if and only if the buyer is harmed.

For complex projects there are a myriad of ways a buyer might be harmed. Consider for example computer software. If a word processor has a bug that leads to a loss of an important document, then the harm is potentially very large. Moreover, there are an unlimited set of ways this could occur. Consider a seller, and let $H$ be the set of events where there is potential harm. For humans such events must have a minimal perceptional level to be salient, which in turn implies a minimal probability $q_{\text{min}}$ that the event occurs, and a minimal harm $h_{\text{min}}$ that makes the potential harm salient. Under a rule of strict expectation damages a seller would suppose that potential harm satisfies:

$$\text{Harm} = \sum_{s \in H} q_s h_s > \#H \times q_{\text{min}} \times h - h_{\text{min}}.$$ 

The point here is that for any reasonably complex project the size of $H$ is very large, potentially infinite. Hence, expected harm is similarly very large, with the result that a rule of unlimited liability for unforeseen events would lead sellers to exit the market. The rule of Hadley v. Baxendale solves this problem by setting $h_{\text{min}} = 0$ for the large set of unforeseeable events, and thereby allowing complex products to enter the market that might not do so otherwise.

Finally, as discussed in section II, the commodities model suggests a solution to Hadley v. Baxendale that is now observed in practice. Rather than viewing the late delivery as a breach of contract with damages due, the market now supplies delivery with different levels of quality. When sending a FedEx package one chooses the speed of delivery. As markets develop we move from contractual specifications of performance to the market selling more differentiated products.

The problem that remains is suppose that Hadley did indeed purchase speedy delivery by rail, and the shipper was slow nevertheless. In this case, speedy delivery is part of the deal. The modern solution is found in FedEx's limits of service:

1) If the Warsaw Convention as amended by Montreal Protocol No. 4 applies to your shipment, FedEx’s liability for loss, damage or delay or any other claim with regard to any shipment is limited to either: (i) the maximum amount set out in the Warsaw Convention as adopted by local law; or (ii) 17 Special Drawing Rights (SDRs) per kilogram#, unless the sender declares a higher value for carriage on the Air Waybill and the appropriate charge is paid.

2) If the Montreal Convention applies to your shipment, FedEx’s liability for loss, damage or delay or any other claim with regard to any shipment is limited to 19 SDRs per kilogram unless you declare a higher value for carriage and the appropriate charge is paid.

3) If for any reason the Warsaw Convention or the Montreal Convention does not govern FedEx’s liability, FedEx’s maximum liability for loss, damage or delay or any other claim with regard to any shipment is limited to US$100 per shipment or US$20.00 per kilogram (US$9.07 per pound), whichever is greater, unless the sender declares a higher value for carriage on the Air Waybill, and the appropriate charge is paid.
4) If a higher value of carriage is declared (subject to the limits imposed on the value that may be declared as noted immediately below), FedEx's liability for loss, damage or delay of a shipment will not exceed its repair cost, its depreciated value or its replacement cost, whichever is the least.

What these rules illustrate is that FedEx cannot guarantee timely delivery. The service/commodity that it supplies is speedy delivery on average, with a set of stipulated damages in the event of loss or damage. This example illustrates the point that the good being supplied by FedEx is not simply the delivery of a good, nor even sure delivery quickly, but is a complex set of contingent goods that in most cases results in speedy deliver, but in some cases might result in the complete loss of one's package with some predefined compensation for the loss. These ideas can also be applied to the determination of liability in tort cases.

**B Strict Liability and Negligence**

The law and economics of tort builds upon the famous Judge Learned Hand rule (see Posner [2011]). This rule follows the basic economics model of decision-making attributed to Savage – first a model of the transaction is created, and then one determines the optimal decision. In the case of Learned Hand, the model first determines negligence and then liability if negligent.

The essential ingredients of the Hand model are as follows. Let $H$ denote the level of harm caused, and let the probability of harm given the actions of the defendant be denoted by $p^0$. Then there is the cost of additional precaution, $B$. Finally, there is the probability of harm given this action, denoted by $p^1$. In that case Learned Hand reasoned that the defendant was negligent if and only if the benefit of precaution was greater than the cost:

$$(p^0 - p^1) H > B$$

If found negligent, then the defendant would be asked to pay the harm $H$. Notice that this is *not* a model of the reasoning carried out by the defendant. When in court the accident has already occurred. What is truly innovative about this rule is that Hand is explicitly following the algorithm suggested by Savage (1954) several years later. He builds an “as if” model of the question at hand to help him reason about the decision process of a potential tortfeasor. That is quite different from the question of whether or not the rule itself will affect future accidents.

There are a number of difficulties with this “as if” approach. First, the Savage [1952] model clearly shows that individuals do not need to think in terms of probabilities when making a decision, hence the use of probabilities is not necessarily a good model of how the tortfeasor was thinking. The tortfeasor in U.S. v. Carroll Towing may have believed that he took all the appropriate actions needed to secure the barge. After the fact we know that this is not true, and the experience with the accident will hopefully be a learning experience that will result in better procedures in the future. The issue is how to determine negligence.

When Hand used the model of precaution to set the negligence standard he was explicitly assuming that
tortfeasors in the future would respond in a predictable fashion. Without question, the empirical evidence supports the hypothesis that individuals modify their behavior in response to punishments and rewards. However, there is also a large body of evidence showing that the exact response can be difficult to predict. In 1991 the National Academies published a study on the use of incentive pay in government (Milkovich and Wigdor [1991]). They recommended that the government not institute widespread incentive pay reform due to the complexity of getting the rule correct. The study never claims that incentives are unimportant, only that simple ex ante models of incentive behavior have been shown repeatedly not to work as intended.

The Arrow-Debreu model of commodities provides an alternative approach that avoids the prospective modeling of incentives. Consider the case of medical malpractice. The provision of medical services is always a risky activity. Whenever surgery is performed there is always a chance of a misadventure. Doctors will often miss symptoms and not correctly diagnose conditions that with hindsight they should have seen. In other words, the product they are selling is not a good outcome, but the promise to do a good job.

The requirement that the standard of care meets community standards is nothing more than an obligation to provide a service with certain characteristics. In particular, the negligence rule as modeled using the model of precaution requires that the care supplied meet community standards. However, recent decisions have pointed out that this is not sufficient. For example, Scott v. Bradford, 1979 OK 165, 606 P.2d 554, established that informed consent and providing information about available alternatives “is as essential as the physician’s care and skill” (Parris v. Limes, 277 P.3d 1259 (2012) 2012 OK 18556-7).

These rulings make sense when viewing the services supplied by a physician as complex commodities. The physician is held liable when the commodity supplied does not meet minimal standards. This is no different than the rule of strict liability where manufacturers are held strictly liable when harm arises from a manufacturing defect, where “[a] manufacturing defect is a departure from a product unit's design specifications. … Common examples of manufacturing defects are products that are physically flawed, damaged, or incorrectly assembled.”

The main difference between strict liability and negligence is the fact that breach of a duty to supply quality is easier to determine in the case of strict liability. Manufacturing defects are explicitly contrasted to design defects and inadequacies in instructions and warnings, which are subject to negligence regimes. The point is that the nature of complex commodities, such as medical services and warnings, varies over time. The negligence rule is an explicit mechanism that allows for time dependence of the standard, and not a fundamental difference in principle.

In both strict liability and negligence cases there is liability when the commodity supplied is substandard. In the case of products, such as cigarettes, we may learn over time that their use is dangerous, which gives rise to new warning obligations. Similarly, new knowledge may change the standard of care in medical practice. However, this standard does not have to be seen as an explicit incentive mechanism. That would entail very complex reasoning regarding how the legal rule will

14 Restatement (Third) of Torts: Products Liability, § 2, comment (c).
15 Id. at § 2.
affect a very heterogeneous group of individuals in the future.

Rather, once we see that medical services are simply complex commodities, then tort law is very much like contract law except that the performance standard is determined by community standards rather than by contract terms. This leads to a much less complex modeling process than that envisioned by the Hand rule. Moreover, rules such as contributory negligence are no different than rules found in contract law that place an obligation upon harmed parties to mitigate the costs of breach by a defendant.

This analysis leaves open the question of how current law affects the decision of a party to breach a duty.

V. The Causal Impact of Legal Rules upon Behavior

The model of precaution is an “as if” exercise – describing how agents would vary their behavior with changes in liability rules. We create such models repeatedly in economics in order to understand potential causal mechanisms, but with experience we now know from work such as Kerr [1975] and many others that one has to be very cautious when using these models in practice.

Of particular importance in economics is dealing with heterogeneity. When taking theory to the data one is faced with the immediate issue that individual decision makers vary greatly in their preferences. Many hold incorrect views of the world. The field of behavioral economics, beginning with the work of Herbert Simon and more recently Kahneman and Tversky [1979], emphasizes the idea that individuals consistently make errors even in apparently simple environments.

Hence, the only sure way to know the effect of a legal rule is not through speculation, but through careful measurement. An interesting development that has occurred in economics over the last 30 years is that while theoretical models have become more complex, empirical methods have become simpler. This due in part to the influence of statisticians such as Freedman [1991] who provide many examples of how sophisticated statistical methods can lead one astray. The dominant method that is used in economics today is the potential outcomes approach we describe next.

A. Potential Outcomes and the Fundamental Problem of Causal Inference

The starting point for Savage is the idea that when making a decision a person builds a model of how each decision leads to different consequences. These different outcomes are potential outcomes. This is different from the realized outcome, which is what we see after the person makes a decision, and then nature rolls the dice to produce a consequence for the individual. Holland [1986] provides an elegant synthesis of these ideas that has become very influential in economics (see Imbens and Rubin [2011] for a modern review of this area).

A classic application is to the effect of education upon future outcomes, an issue that is central to a number of legal cases involving access to schools. Suppose that a person is considering two actions at the end of high school. She could either find a job (choice J) or go to college (choice C). At the end of
high school the individuals has some self-awareness regarding her skills and attributes, say that these are given by $\theta$. For simplicity, let us suppose that markets are complete and that the individual only cares about net lifetime income given by $Y(D, \theta)$, where $D$ is the decision of either finding a job ($D=J$) or going to college ($D=C$).

The simplest formal model that an individual could build would be to associate each choice with future earnings. Suppose the individual is concerned with maximizing her future income, in which case she is concerned with the potential outcomes: $\{Y(J,\theta),Y(C,\theta)\}$—income she would get from getting a job now, $Y(J,\theta)$, and the income she would get from a college education, $Y(C,\theta)$. These are potential outcomes because at the time she makes a decision they have not been realized. A natural way to frame the problem is in terms of how much her income would go up by attending college—in that case we can define the causal effect of a college education:

\[
(1) \ CE(\theta) = Y(C,\theta) - Y(J,\theta)
\]

The standard model of human capital assumes that an individual attends college if and only if the causal effect of college is positive. The issue is how does the individual use the available evidence to make this choice? If the decision were for instance what food she should eat, or what wine she should buy, then at a relatively low cost she could try each and then choose the one she prefers.

Holland [1986] observes that there is only one sure way to measure (1)—this requires having the person find a job and observe their income. Next, we take the same person and then have them take a college education. To do this would require a time machine! If we did have such a time machine, like the hapless hero in the movie *Groundhog Day*, we could experiment with different life experiences until we made the best choices.\textsuperscript{16} This is clearly impossible, an observation that Holland [1986] calls the fundamental problem of causal inference.

Measuring the returns to a college education is a fundamental question in labor economics that has been extensively studied since the classic work of Mincer [1974] (see Card [2001] for an excellent review). Since we cannot measure the returns to college for a particular individual, the only way we can estimate $CE(\theta)$ is to build a model of the world. In the case of college education the standard modeling assumption is that individuals with similar characteristics have the same potential outcomes.

If we can find data where two individuals have the same characteristics, but make different choices, then we can measure the causal effect by comparing the outcomes of these choices. Economists have developed a number of techniques for doing this carefully. In the next section we discuss how this has been achieved with tort law.

**B. Results for Tort Law**

Estimating the impact of the law upon behavior is very difficult. Many factors are changing at the same time, and hence it is difficult to know if observed changes are due to a rule or due to some unobserved factor. In keeping with the discussion above, theoretical models of tort tend to emphasize particular types of incentives to the exclusion of others, with the result that they will not always make the best empirical predictions. Hence, it is necessary to turn to the data to determine what changes in tort law will do. One of the best ways to measure the effect of the law is to view the United States as a

\textsuperscript{16} In *Groundhog Day* Bill Murray plays Phil Conners, an arrogant TV weatherman who is in a time loop repeating the day over and over until he finally learns to become a good person. Like Holland's article, critical appreciation of the movie has increased over time and it was listed in the United States Film Registry in 2006.
laboratory where each state sets its own rules.

Even though the United States has a common culture, one cannot use cross-state variation in rules to look at the effect of the law. Each state has a unique history, meaning that observed rules and outcomes have multiple sources. Rather, the standard approach is to use variations over time to explore the causal effect of a rule. The idea is that we can compare relevant outcomes in the year before and after a rule change to see if there is an effect upon behavior. In this approach, the state before the rule change is used as the best approximation to what the state would have been like had the rule change not taken place. Even this approach has drawbacks, as discussed by Bertrand et al. [2004], but for the moment it is the source of the best evidence of the effect of legal rules.

Cohen and Dehejia [2004] have a nice study that looks at the effect of the introduction of no-fault automobile insurance upon traffic fatalities. They use variations in state laws regarding no-fault insurance over the 1970 – 98 period and find that a move from a regime with fault to no fault causes a 6% increase in traffic fatalities. What one cannot exclude is the possibility that changes in the law are associated with changes in the population that are themselves correlated with accident rates and the passage of the law.

This issue is more easily addressed in the context of medical care. Kessler and McClellan [1996] explore the impact that changes in state law have on the outcomes of elderly heart attack patients on Medicare. Heart attack patients are a good group to study because when a heart attack occurs the patient has to go to the nearest hospital, and in particular will generally not cross state lines to get into a better hospital. They find that a reduction in tort liability has a small, close to insignificant effect upon patient outcomes, but a large negative effect upon costs.

Due to a lack of data, Kessler and McClellan [1996] have to use rather broad tort categories. For example, they treat reform to the collateral source rule and the rule of joint and several liability as a single rule change. Currie and MacLeod [2008] update the law data and are able to use finer granularity regarding the law. We explore the effect of tort reform upon both the incidence of C-sections and outcomes to the mother and child.

Our first result is that a decrease in liability (either by reducing the cap on damages or disallowing harm due to pain and suffering) led to an increase in C-section rates. Many find this result counter-intuitive because there has been so much discussion of the idea that C-sections are a form of “defensive medicine.” In a world in which doctors were starting from the optimal C-section rate and were always acting in the best interests of their patients, then fear of lawsuits might push them to do more C-sections. This is the type of thinking that is based upon the model of precaution – tort liability leading doctors to be more careful to avoid bad outcomes and hence to higher C-section rates. However, the real world C-section rate is thought to be much higher than necessary, suggesting that the marginal C-section is an unnecessary surgery that is not in the best interests of the patient. That is, there are other forces leading doctors to perform unnecessary surgeries, and this tendency is restrained by the tort system. Therefore, when liability is reduced, C-sections rise. This counter-intuitive result provides a concrete demonstration of the dangers of relying on an overly simplistic model of precaution without adequate empirical evidence.
A second lesson from this study concerns the importance of dealing with heterogeneity in treatment effects. We find that most of the variation in C-section rate occurs for women whose medical condition is in a grey area – that is, there is some indication that a C-section may be appropriate, but it is a question of judgment. For these marginal cases, the gain from a C-section is close to the cost. However, C-sections are surgeries and there are a number of tort cases involving botched C-sections. A rise in C-section rates as a consequence of reduced liability is consistent with poor surgeons increasing their C-section rates because they know they are less likely to be sued. We also find that the law has no effect upon high risk patients, where a C-section is more likely and the quality of the physician is likely to be higher.

In our most recent work, Currie and MacLeod [2013], we are able to disentangle diagnostic skill from the surgical skill of obstetricians. In the context of the current discussion, we can think of the commodity the physician supplies as a complex good consisting of both aspects of skill. We show that while higher surgical skill is beneficial to high risk women, better diagnostic skill benefits both high and low risk women. The former are more likely to receive C-sections from a skilled diagnostician, while the latter are less likely to receive C-sections, and both groups benefit from better matching of their medical procedure to their needs.

Another surprising result comes from our work on the reform of the doctrine of joint and several liability (JSL). When there are multiple tortfeasors in a regime of JSL a plaintiff can recover all of her losses from a single defendant. However, this does not mean that the other defendants are not liable. Landes and Posner [1980] explore the contribution movement in the U.S. – contribution is a rule change that allowed the defendant who is found liable to recover her losses from the other tortfeasors.

There has been a move to modify JSL to a regime in which each tortfeaso is responsible only for the harm that he caused. One of the motivations comes from the area of medical malpractice. When there is a bad medical outcome it is common to list hospital nurses as co-defendants. Under the respondent superior doctrine, and with JSL, the hospital could end up liable for the full amount of damages because the nurses are employees of the hospital.

However, several observers have pointed out that the new rule does not in fact change overall liability. Hence, one might expect the rule change to not have any impact on behavior. However, Carvell, Currie and Macleod [2012] point out that in the real world, other defendants are often judgment proof. Under JSL it is not worthwhile for the “deep-pocketed” defendant to sue the others for contribution. But the calculus is very different under JSL reform. With reform, even if another tortfeasor is judgment proof, the “deep pocketed” defendant may have an incentive to join them to the case in order to reduce his own liability. We show that this is not only a theoretical possibility, but that there is evidence that JSL reform has reduced the rate of accidental death in the United States.

VI. Discussion

The model of precaution is an excellent first order way of thinking about how individuals respond to the incentives they face in their environment. It is nevertheless a relatively crude model. In this paper we have discussed the model of commodities introduced in general equilibrium theory and how it is the
starting point for a richer and more nuanced model of exchange that can be used in law and economics.

We have also discussed the modern model of rational choice developed by Savage [1952], and how it is related to the model of commodities. In particular, Savage emphasized that the first step in making a rational choice is the careful modeling of the environment and the consideration of the future states that might occur. Savage solved a fundamental problem in rational choice theory by freeing the decision maker from the need to have a correct model of the world. Rather, Savage showed that once a decision-maker had built her worldview, then the probability of an event is constructed from her preferences.

This raises some difficulties for the well known Hand rule for negligence because in many cases the probability needed for the rule is unknown, or may be unknowable. The alternative we suggest is based upon the model of commodity used in general equilibrium theory. It recognizes that commodities may be complex and state contingent. In the case of medical care a doctor does not promise to cure a patient, only to be diligent with her knowledge, and to supply the patient with complex, multi-dimensional services. The reason that the negligence standard is set in court is because it is an essentially dynamic standard that adjusts with new knowledge.

We have used the same ideas to provide an alternative view of Hadley v. Baxendale. That rule fits in very naturally with the Savage model in that we can view a contract as an expression of the model of the world that parties have built to govern their relationship. In a dynamic world we are constantly learning new possibilities, and by having limits on liability for unforeseen events we lower the cost for the entry of new goods and services. One cannot claim that this is optimal, but our model does predict, consistent with the analysis in Danzig [1975], that the rule of Hadley v. Baxendale was conducive to innovation. The current state of the art allows us to tease out a relationship between incentives and behavior in the short run. An open question for future research is whether or not we can establish a causal relationship between such legal rules and long run economic performance.

VII. References


Review 73, 1-51.


