# On Optimal Legal Change, Past Behavior, and Grandfathering

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**ABSTRACT**

When is it socially advantageous for legal rules to be changed in the light of altered circumstances? In answering this basic question here, a simple point is developed—that past compliance with rules tends to reduce the social advantages of change. The reasons are twofold: adjusting to a new legal rule involves costs, and the social benefits of change are only in addition to those of past compliance. The general implications are that legal rules should be more stable than would be appropriate were the relevance of past behavior not recognized and that grandfathering, namely, permitting noncompliance, is sometimes desirable. These points have broad relevance, often explaining what we observe but also indicating possibilities for reform, such as in the regulation of pollution. The analysis is related to the conventional reliance-based justification for the stability of the law, the literature on legal transitions, and economic writing on optimal legal standards.

## 1. INTRODUCTION

The object of this article is to examine a primary question about legal rules, namely, when is it desirable for legal rules to be modified in the light of new circumstances? The major contribution of the article is its identification and elaboration of the point that parties' past compliance with legal rules may reduce the net social advantages of legal change. The general implications are that legal rules should be more stable than

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would apparently be appropriate, that is, appropriate were past behavior not taken into account, and also that a policy of grandfathering—of allowing noncompliance for parties already participating in an activity and complying with rules in the past[1]—should often be employed.

The kernel of the argument to be developed is easily appreciated. Consider a firm that installed a type of smoke scrubber that satisfied pollution-control rules 5 years ago when the firm built a factory. Suppose that advances in technology have resulted in the availability of a new type of smoke scrubber that is superior to the old: the new scrubber reduces pollution even more and is cheaper to purchase and operate.

Should there be a change in the legal rule requiring the firm to use the new type of smoke scrubber in its factory? Quite possibly not, and for two reasons. First, the social costs of a change would be distinctly positive—the firm would have to purchase the new scrubber, and the firm would often bear various adjustment costs as well (it would have to remove the old scrubber, and it might have to engage in retrofitting to accommodate the new scrubber). Second, the social benefits of a change would be only incremental, for if the old scrubber were kept, it would reduce pollution to a certain degree. If the costs associated with a change to the new scrubber would outweigh the incremental social benefits, it would be socially best to permit the firm to continue to use the old scrubber.

In contrast, if a firm were building a factory afresh, the firm should obviously be required to install the new smoke scrubber. The new scrubber costs less than the old type, and the social benefits that the new scrubber would yield would be total, not incremental, because by hypothesis there would be no existing factory that would already have installed a scrubber of some type.

This simple example illustrates the conclusion that it may be socially advantageous to grandfather a party that complied with a legal rule in

1. This general meaning of "grandfathering" will be employed below. For standard definitions of "grandfather clause," see *Black's Law Dictionary* (2004, 8th ed., p. 718): "[a] provision that creates an exemption from the law's effect for something that existed before the law's effective date"; *Merriam Webster's Collegiate Dictionary* (1993, 10th ed., p. 507): "a clause creating an exemption based on circumstances previously existing." The word "grandfathering" and its cognates are widely used, although they do not usually appear in the language of statutes.

the past, even though the rule should be altered for new participants in the activity.[2]

A closely related conclusion applies when it is impractical for the legal system to treat new participants and past participants differently, in other words, when grandfathering is infeasible. In that case, if a legal rule were altered, inefficiency would result, because the past participants for whom a change would be socially wasteful would not be grandfathered. Hence, it would often be desirable for the law to remain stable until the inefficiency of forced change for the parties who complied with the law in the past would be outweighed by the benefits of change for others.

These conclusions about the importance of prior behavior to the calculus governing the desirability of legal change, grandfathering, and legal stability have very broad applicability, as they do not depend on the area of law.

However, two qualifications to the analysis will be noted. The first is that past behavior matters only when it is of a durable nature (a smoke scrubber may last for years). When instead past behavior concerns nondurable, modifiable effort (such as the frequency of inspection of toxic-waste-containing tanks for leaks), legal rules should not depend on past behavior and thus should be adjusted in response to all manner of changes in conditions.

The second qualification is that legal rules should reflect past behavior only when the rules are based on legal standards (notably, regulatory standards or due-care standards used in applying the negligence rule). When instead legal rules are premised on strict liability, parties will automatically be induced to take past behavior into account in a socially appropriate manner. Hence, under strict liability, there is no basis for grandfathering, such as for cabining damages to reflect an earlier anticipated level of harm.

The organization of the article is as follows. In Section 2, I develop theoretically the main argument that I have just described. To this end, I examine informally a stylized model of precautions that reduce the risk of harm. There are 2 periods in the model. In the first, uncertainty exists about the harmfulness of the activity or about the cost or technology of risk reduction. In the second period, the uncertainty has been re-

2. A similar argument to that of the example demonstrates that it may be desirable to grandfather a party who participated in an activity in the past when there was no legal rule (rather than a less rigorous rule) applying to the activity at the time. See Section 3.4.

solved—information about the magnitude of harm that the activity might cause and/or about new opportunities for risk reduction has become available. This information may or may not make it socially desirable for the level of precaution to change. The implications of the desirability or undesirability of change in the level of precaution for the stability of legal rules and for grandfathering are considered.

In Section 3, I study the role in the model of a number of logically secondary, but sometimes empirically important, factors, including maintenance costs, the scrap value of equipment, transition costs, and modification of property. I also address informational problems that confront legal authorities, and I discuss legal policy when grandfathering is too administratively difficult to accomplish. In Section 4, I present a formal version of the model.

In Section 5, I comment on the law in the light of the analysis. I first ask whether legal rules do, as an approximate matter, exhibit a measure of stability where the analysis suggests that they ought, which is to say, where parties' actions have durable aspects and are subject to legal standards. I then consider grandfathering. I note that grandfathering can be seen as a general, though implicit, feature of the negligence determination in tort law. I also survey two contexts in which explicit grandfathering is a prominent feature—regulation of air pollution from power plants and real estate zoning—and I consider how well their characteristics conform to the theory of optimal grandfathering. I suggest that although the observed grandfathering rules appear to be rational in a rough qualitative sense, the rules sometimes appear to suffer from substantial defects. Notably, the grandfathering of out-of-date power plants is problematic, mainly because it is of long duration and permits old, highly polluting plants to be maintained and modified significantly yet still remain grandfathered.

In Section 6, I discuss several views found in commentary and scholarly writing about legal change and relate them to the analysis of this article. One view concerns the notion that legal rules ought to be relatively stable because individuals rely on the rules.[3] I find this view

3. See, for example, *Landgraf v. USI Film Prod.* (511 U.S. 244, 265–66, 114 S. Ct. 1483, 1497 [1994]): "Elementary considerations of fairness dictate that individuals should have an opportunity to know what the law is and to conform their conduct accordingly; settled expectations should not be lightly disrupted. . . . In a free, dynamic society, creativity in both commercial and artistic endeavors is fostered by a rule of law that gives people confidence about the legal consequences of their actions"; *Harvard Law Review* (1978, pp. 1427, 1494–96), which discusses property holders' reliance interests in the

consistent with the argument given here for legal stability but incorrect if premised on the idea that participation in activities would be undesirably chilled by called-for legal change. Another view is found in the economically oriented literature on legal transitions, the major claim of which is that grandfathering is often socially disadvantageous (see especially Graetz 1977; Kaplow 1986; Shaviro 2000). This claim holds only if liability is strict. If, as is usually true, however, liability is based on fault or a regulatory standard, the claim of the transitions literature appears to be misleading, because it is patent that grandfathering may have a desirable role to play.[4] I then comment on prior economic literature on legal rules and incentives. This literature does not address the question of the relevance of past behavior to later optimal behavior and to optimal change in rules. In Section 7, I briefly conclude.

## 2. A MODEL OF OPTIMAL LEGAL CHANGE

### 2.1. Assumptions

In the standard model of potentially harm-creating activity, a party chooses a level of precaution in order to reduce the likelihood of harm (see, for example, Brown [1973] and, more generally, Landes and Posner [1987] and Shavell [1987]).[5] As was indicated above, I will consider a 2-period version of the model, and I will suppose that some parties engage in the activity in both periods, whereas others enter the activity only in the second period.

Two alternative assumptions will be made about precautions. Precautions may be durable, notably, involve the acquisition of a safety device, such as the smoke scrubber mentioned above, or relate to fixed physical aspects of property, such as the number and location of exits from a building (but see Section 2.2 on the interpretation of durable precautions) or its setback from a boundary line. It will be assumed that

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context of zoning; Hochman (1960, p. 727), which emphasizes reliance as the major factor in statutory retroactivity cases.

4. But, to be clear, the conclusions of the transitions literature are not misleading and have relevance in the area of taxation, to which the literature was originally addressed. The reason is that tax rules can often be viewed as a species of, or analogous to, strict liability rules rather than rules requiring compliance with legal standards. See Section 6.

5. In some versions of the standard model, the exercise of precautions affects not only the likelihood of harm but also its magnitude. This difference is inessential for my purposes, and for simplicity I examine here a model in which only the likelihood of harm is affected by the level of precaution.

if a party invests in a durable precaution in period 1, the party can benefit from it in period 2 without additional cost.[6] If, however, a durable precaution is changed in period 2 from what it was in period 1, a cost, that of the new precaution, will be incurred. For example, if a smoke scrubber of type A is purchased in period 1, and it is replaced by a smoke scrubber of type B in period 2, the cost of the type B smoke scrubber will be borne in period 2. If scrubber A is replaced by scrubber B, the total cost of precautions over the 2 periods will thus be the cost of scrubber A plus the cost of scrubber B, but if scrubber A is used over both periods, the total cost of precautions will be just that of scrubber A.

Precautions may instead be nondurable. Typically, nondurable precautions take the form of effort to reduce risk, such as the example from the Introduction of the frequency of inspection of a holding tank for leaks or the care taken in driving. It is natural to assume that an effort to reduce risk requires the bearing of a cost each period the effort is made and, further, that the cost of effort in period 2 is independent of the effort made in period 1. The presumption, for instance, is that the cost of inspecting holding tanks with a frequency of three times a week in year 2 is independent of the frequency of inspection of the tanks in year 1. Hence, the cost of nondurable precautions taken in the 2 periods is assumed to be simply the cost of the precaution taken in period 1 plus the cost of the precaution taken in period 2.[7]

Another assumption that I make is that there is uncertainty at the outset about how harmful the activity is or about the cost or the technology of risk reduction. By the beginning of period 2, however, the uncertainty is resolved—the nature of the harmful activity or opportunities for risk reduction is learned. For concreteness, one might imagine that at the beginning of period 1, it is thought that the harm from the activity could turn out to be anywhere in the range between $100,000 and $1,000,000; and by the beginning of period 2, the true magnitude of the harm will become known (perhaps because an accident will occur

6. The assumption that a durable precaution can be enjoyed in period 2 without any additional cost is made for simplicity. I relax the assumption in Section 3 and allow for the possibility that a maintenance cost must be incurred in period 2 to continue to benefit from the precaution.

7. Grady (1988) also distinguishes between durable and nondurable precautions in an analysis of the negligence determination; he emphasizes that courts face difficulty in obtaining evidence about past nondurable precautions but not about past durable precautions.

and reveal the harm).[8] Or one might have in mind a situation such that at the beginning of period 1, it is thought that a technological advance could occur and, if so, would result in a risk-reducing device that would be twice as effective as present devices and cost the same; and by the beginning of period 2, whether the new device will be available will be known. The importance of the assumption that uncertainty is resolved by the beginning of period 2 is that it may then become desirable for precautions and the law to change in the light of the new information and circumstances.

### 2.2. The Interpretation of Durable and Nondurable Precautions

Although in the model the assumption is that the effect of a durable precaution on risk in period 2 is identical to its effect in period 1, it will be apparent that the qualitative character of the conclusions to be reached would be similar as long as the precautions taken in period 1 have some effect on risk or harm in period 2. Hence, a durable precaution should be viewed broadly, as essentially any action that influences the probability or magnitude of harm beyond period 1.[9]

The taking of durable precautions may sometimes be an implicit aspect of compliance with a legal rule. For example, suppose that a factory is required to use natural gas as a fuel for its power plant (say, because the alternative of coal would generate substantial pollution). The burning of gas does not itself constitute a durable precaution, but it may well be associated with such: the factory might have purchased a kind of furnace best suited to burn natural gas, it might have installed a pipe connecting the main gas line to its power plant, and it might have chosen its location in order to be assured of a steady supply of gas. These decisions have durable aspects because they allow the factory to continue to use natural gas more cheaply in the future.

Another comment about the generality of the notion of durable precautions concerns training and intellectual capital and also investments in the use of particular financial arrangements and reporting practices. If an organization trains its employees to undertake a specific risk-lowering task, say, an airline teaches its mechanics to overhaul a kind of aircraft engine according to a set procedure, then the training in-

8. To amplify, the activity is assumed always to cause just one level of harm if an accident occurs. What that level is is not known in the beginning of period 1, but it is known by the beginning of period 2.

9. See Sections 3 and 4.5 on variations of the simple assumption that a durable precaution has the same effect in period 2 as it did in period 1.

vestment is a form of intellectual capital that has a durable aspect in that it yields benefits every time a trained employee undertakes the task. Likewise, organizations and individuals often make particular financial and contractual arrangements and collect and organize data to satisfy regulatory demands (consider, for instance, how retirement plans must be established, maintained, and reported on to satisfy Employee Retirement Income Security Act regulations). These legal compliance efforts are substantial in that they involve learning, the establishment of procedures, legal services, and the like, and they have a durable dimension in that they can continue to be employed after they are made.

With respect to nondurable precautions, the main interpretive observation worth making is that not only effort but also a physical resource that is consumed within a period should be viewed as an example. The use of a windshield wiper blade might be considered a nondurable precaution, assuming that the length of the relevant period exceeds the life of the wiper blade, for then a different kind of blade could be employed in the next period, and its cost would not depend on that of the prior blade.

### 2.3. Socially Optimal Behavior

In order to ascertain how well legal rules function and how they ought to be designed, socially optimal behavior must be delineated. I will usually employ as a social welfare criterion the analytically convenient objective of minimizing social costs, namely, the costs of precautions over the 2 periods plus the expected harm done. This social goal reflects the notion that precautions as well as harms are socially expensive, so precautions should be taken only if they accomplish sufficient good in reducing harm.[10]

Given this social objective, what is socially ideal behavior? Let us begin by reviewing the standard 1-period model of harm and precaution. In this model, the best level of precaution, which I will refer to as the conventionally optimal level of precaution, minimizes the cost of precaution plus the expected harm in the single period at issue. Thus, if the question is which is better, no precaution or a particular, named precaution, the answer is simple: If the cost of the precaution is less than

10. Were I to consider other social goals, such as compensation of victims of harm, the qualitative conclusions would not be altered, for they depend mainly on there being a cost-saving advantage to maintaining durable precautions. Inclusion of social goals in addition to those I study would only cloud the analysis, even though in reality of course the social objective is more broad than the minimization of social costs as defined here.

the reduction in the expected harm it brings about, the precaution should be taken. If the cost of the precaution is $1,000, and it lowers the risk of a $500,000 harm from 10 to 8 percent, it lowers the expected harm by 2 percent × $500,000 = $10,000, so it is worth taking.[11] More generally, the question may be which precaution to take among an array of different precautions, and the possible precautions might constitute a continuum. To determine the optimal level of precaution in this context, one can conceive of deciding how much to spend on precautions by asking whether, by spending another dollar, the expected harm would be reduced by more than a dollar; as long as the answer to this question is yes, the extra dollar should be spent. At a certain point, though, spending another dollar will not be worthwhile, since the effectiveness of precautions will have fallen to just less than a dollar; at this point, the optimal expenditure on precautions will have been reached. In general, the more harmful an activity is, the higher will be the optimal level of precaution, and the optimal level of precaution will rise in a more or less continuous fashion with the expected harmfulness of an activity.

Now let us consider the 2-period model with uncertainty surrounding the level of harm,[12] and let us first study the case of nondurable precautions, because it is the easier case to understand. Here the cost of precautions is independent in each period, so we can view the periods separately. Because in the beginning of period 2 the level of harm that would occur in an accident is assumed to be known, the optimal level of precaution will be whatever is conventionally optimal for that level of harm. If the level of harm were an accident to occur turns out to be $200,000, then the precaution taken in period 2 ought to be appropriate for a $200,000 potential harm, and if the level of harm turns out to be $600,000, then the precaution taken in period 2 ought to be suitably higher, and so forth.[13] In the beginning of period 1, however, the level of harm that would result from an accident is not known, so the level

11. As in this illustration, the expected harm means probability-discounted harm. That the expected harm is included in social costs means that society displays risk neutrality rather than risk aversion with respect to harm. I make the assumption that society, and, below, that decision makers, are risk neutral mainly for analytical convenience. On the concepts of risk neutrality and risk aversion, see, for example, Pindyck and Rubinfeld (2001, pp. 55–160) and Shavell (1987, chap. 8).

12. The case in which uncertainty concerns the cost (or technology) of risk reduction is similar, as I will occasionally remark in later footnotes.

13. Likewise, in the case in which uncertainty attaches to the cost of risk reduction and it turns out to be inexpensive to reduce risk, then the level of precaution ought to be suitably higher.

of precaution should reflect this uncertainty. In the model, it is readily shown that the optimal level of precaution in period 1 equals the level that would be appropriate for the expected harm given that harm occurs. For instance, if the harm is equally likely to be anywhere in the range between $100,000 and $1,000,000, then the expected harm conditional on its occurrence is the midpoint of this range, namely, $550,000, so the precaution taken in period 1 should be that which is optimal for a potential harm of $550,000.[14]

We can summarize as follows. In the case of nondurable precautions, the optimal period 1 level of precaution is the conventionally optimal level for the expected harm. The optimal period 2 level of precaution is the conventionally optimal level for the then-known harm, whatever that may be. Thus, the optimal period 2 level of precaution is generally different from the optimal period 1 level. Note as well that the optimal level of precaution for a party who first enters the activity in period 2 is the same as the optimal level of precaution in period 2 for a party who had engaged in the activity in period 1.

Next let us turn to the case of durable precautions, and let us again begin by considering what is best for a party in period 2. I want to show that the party should not change its precaution from what the precaution was in period 1 unless the harm turns out to be sufficiently high.[15] To illustrate, suppose in period 1 that a party took the precaution of buying a safety device that lowered the risk of harm to 7 percent. Assume that the harm in period 2 turns out to be $700,000, that the conventionally optimal precaution for harm of $700,000 involves a cost of $20,000, and that that precaution would lower the risk of harm to 5 percent. Should this new precaution be taken? If it is not taken and the period 1 safety device continues to be employed, the risk will remain at 7 percent, so the expected harm will be 7 percent × $700,000 = $49,000, but no added cost of precaution will be incurred. If instead the new, conventionally optimal precaution is taken, an added cost of $20,000 will be borne, which implies that the social costs in period 2 will be $20,000 + 5 percent × $700,000 = $55,000, which is higher than

14. For simplicity, I will often refer below to the expected harm conditional on harm occurring (here $550,000) simply as the expected harm, even though the unconditional expected harm equals the probability of harm occurring multiplied by the expected harm conditional on its occurrence.

15. In the case in which uncertainty attaches to the cost of risk reduction, the analogue is that it is best for the party not to change its precaution from the period 1 level unless the cost of risk reduction turns out to be sufficiently low.

$49,000. Hence, the new conventionally optimal precaution should not be taken—the party should stand pat with the original period 1 precaution. One way of understanding this conclusion is to observe that the cost of a change in precaution is $20,000, whereas the benefit is only due to the marginal effect of the 2 percent drop in risk (that is, 7 − 5 percent) on expected losses, 2 percent × $700,000 = $14,000, which is less. If, though, the harm were sufficiently high, then it would be worthwhile changing to the conventionally optimal precaution. For example, suppose that the harm is discovered to be $900,000 and that the conventionally optimal precaution for this harm costs $22,000 and lowers the risk to 4 percent. Then if the period 1 precaution is maintained, the social costs will be 7 percent × $900,000 = $63,000, whereas if the precaution is changed to the new conventionally optimal level, the social costs will be $22,000 + 4 percent × $900,000 = $58,000, so it will be best for the party to change to the conventionally optimal level of precaution. Here the $22,000 is worth spending because the marginal reduction in risk of 3 percent (that is, 7 − 4 percent) is justified by the high potential harm, for 3 percent × $900,000 = $27,000.

We can summarize and generalize as follows. In the case of durable precautions, a party ought to continue with its period 1 precaution in period 2 if the cost of the new conventionally optimal precaution for period 2 harm would exceed the marginal reduction in expected harm that would be accomplished by a change to this precaution.[16] Hence, it is socially desirable for a party to maintain its period 1 precaution in period 2 as long as the known harm turns out to fall below a threshold; otherwise, the party should change its precaution to the conventionally optimal level for the known harm.

Consider now the best level of precaution at the beginning of period 1. At that time, the harmfulness of the activity is not known, and one

16. This conclusion can be expressed algebraically (see Section 4 for details). Let $p(x_1)$ be the probability of harm resulting from the expenditure on precaution $x_1$ made in period 1, and let $x^*(h)$ be the conventionally optimal precaution expenditure when harm is known to be $h$ (that is, $x^*(h)$ is the $x$ that minimizes $x + p(x)h$). Then if there is no change in precautions in period 2, the social costs are $p(x_1)h$, whereas if the precaution is changed to the conventionally optimal level, the social costs in period 2 are $x^*(h) + p(x^*(h))h$. Hence, it is best not to change precautions as long as $p(x_1)h < x^*(h) + p(x^*(h))h$ or, equivalently, $x^*(h) > [p(x_1) - p(x^*(h))]h$. Similarly, in the case in which there is uncertainty about the cost of risk reduction rather than $h$, let $c$ be the cost of a unit of precaution, assume that $c = 1$ in period 1, let the uncertain value of $c$ in period 2 become known at the beginning of period 2, and let $x^*(c)$ be the number of units of precaution $x$ that minimize $cx + p(x)h$. Then it is best not to change precaution as long as $p(x_1)h < cx^*(c) + p(x^*(c))h$ or, equivalently, $cx^*(c) > [p(x_1) - p(x^*(c))]h$.

might think that the optimal level of precaution is the conventionally optimal level for the expected harm, namely, the conventionally optimal level of precaution for harm of $550,000 in our example. (This level was optimal, recall, in the case of nondurable precautions.) However, in the case of durable precautions, the optimal level of period 1 precaution is higher than the conventionally optimal level for the expected harm. The essential reason is that because precautions are durable, when precautions are taken in period 1, it will often be best not to alter them in period 2, as was described in the previous paragraph. This in turn means that the social payoff from risk reduction flowing from a period 1 precaution may extend to period 2 and thus raises the optimal investment in the period 1 precaution (above what it would be in the case of nondurable precaution).

Last, consider what is socially optimal for a party entering into the activity only in period 2, so it will be participating in the activity in just that period. The party should take the conventionally optimal level of precaution that is appropriate for the level of harm, which is known, as the model that applies to the party is in effect just the standard 1-period model. In particular, what is optimal for the party is different from what is optimal for a party who engaged in the activity in the first period, because for that party, as has been emphasized, it is optimal to maintain the first-period precaution unless the harm is sufficiently high. For example, what might be optimal for those parties who engage in the activity in both periods is to choose the period 1 precaution equal to the conventionally optimal level for harm of $600,000 and to maintain the period 1 precaution in period 2 unless the harm turns out to exceed $800,000, in which case it is optimal for them to take the conventionally optimal precaution for the level of harm that is observed. But those parties only entering the activity in period 2 should always take the conventionally optimal precaution for the level of harm that eventuates. Hence, if the harm is between $600,000 and $800,000, it is optimal for those entering the activity in period 2 to take greater precautions than do those who had engaged in the activity the previous period.[17]

17. Observe also that if harm turns out to be less than $600,000, those entering the activity should in principle take precautions that are lower than those who engaged in the activity in the first period. This makes sense because, not having invested in a higher level of precaution, those entering the activity should take a level of precaution that reflects only the known harm in period 2.

### 2.4. Strict Liability

Having described socially optimal behavior in the 2 periods, I now consider how it can be achieved. Under strict liability, parties pay for the harm that they cause, whatever the harm turns out to be.[18] It is evident that, because a party bears the full social costs of its decisions under strict liability, the party will make all of its decisions in a socially optimal way. In particular, the party will choose optimal precautions for each period that it engages in the activity, whether the precautions are durable or nondurable.[19] For instance, if the precautions are durable, the party will change its precaution in period 2 only if the harm is sufficiently large, for if the harm is not very large, it will be cheaper for the party to bear higher expected liability payments than to reduce them by spending on the new conventionally optimal precaution.

As a corollary to what was just observed, we can say that there should be no grandfathering under strict liability. In the context of strict liability, the interpretation of grandfathering is some kind of insulation from liability in period 2 for parties who participated in the activity in period 1, notably, limiting the magnitude of damages to the harm that was foreseen in period 1, even if the harm turned out to be higher in period 2. Such grandfathering under strict liability is not only unnecessary to induce optimal precautions but it also could be socially undesirable because it could dilute incentives to take these precautions.

### 2.5. Negligence or Regulatory Standards

Under the negligence rule or a regulatory standard, parties are required to adhere to a level of precaution that the state chooses. I will assume here that parties comply with the required level of precaution owing to the threat of liability for negligence or of penalties for violation of regulatory standards. Hence, the question to be addressed is how legal standards ought to be set, and the answer is simply that the standards ought to equal the optimal levels of precaution described above.

Accordingly, from what I concluded in Section 2.3, we have the following: If precautions are nondurable, the best standard in period 1 is the conventionally optimal level of precaution for the expected harm, and the best standard in period 2 generally is different and equals the

18. In the model I abstract from contributory behavior of victims for simplicity, and hence I do not consider strict liability with a defense of contributory negligence.

19. This conclusion also holds under a corrective tax, such as a pollution tax, that is set equal to the expected harm that a party generates.

optimal level of precaution for the then-known harm. Grandfathering is not optimal.

However, if precautions are durable, the best standard in period 1 exceeds the level of precaution that would be appropriate for the expected harm, and grandfathering may be desirable. If in period 2 the known harm is below a threshold, grandfathering is optimal—parties who engaged in the activity in period 1 can maintain their period 1 precaution—but parties who enter the activity in period 2 should take the conventionally optimal precaution for the known harm. If in period 2 the known harm exceeds the threshold, then parties who engaged in the activity in period 1 should change their precaution to the conventionally optimal precaution for the harm, which is the precaution that new parties should take.

## 3. EXTENSIONS OF THE MODEL

I now want to consider briefly a number of factors to add greater realism to the model. I will focus on the case of central interest, that of durable precautions in which legal rules set out negligence or regulatory standards.

### 3.1. Maintenance Cost

It was assumed above that if a party employed its period 1 precaution in period 2, the party would bear no additional cost. But there is often a maintenance cost that must be incurred to continue to use a durable precaution, such as the cost of keeping a safety device in good repair or the cost of operating it. Because the bearing of a maintenance cost makes retaining the period 1 precaution less attractive, the social desirability of continuing to use the period 1 precaution in period 2, and of grandfathering, is reduced. In the illustration in which the period 2 level of harm turns out to be $700,000 and grandfathering is optimal, suppose that a maintenance cost of $9,000 must be incurred to continue use of the period 1 precaution. Then, if that is done, the precaution-associated cost in period 2 will be $9,000, whereas if the new precaution is taken, the cost will be $20,000. Hence, the net cost of a change to the new precaution would be only $11,000, whereas the marginal reduction in expected harm would be $14,000, which is greater, so grandfathering would not be desirable. This illustrates the point that, given maintenance costs, grandfathering is optimal only when the cost of a new precaution

minus the maintenance costs associated with the period 1 precaution exceeds the marginal reduction in expected harm that would be accomplished by the change in the precaution.

### 3.2. Scrap Value

Another assumption made above was that, if a party invested in a durable precaution in period 1 but then changed to a different precaution in period 2, its cost of precautions over the 2 periods was the sum of the costs of both. This assumption would be appropriate where a durable precaution is a safety device for which the party would obtain no value if the party were to change to a new device in period 2. However, in some circumstances, the party would obtain value for the period 1 device by selling it on a secondhand market or by using it elsewhere for some purpose. To the degree that the party can obtain such a scrap value for the period 1 device, the social cost of changing the precaution falls. Hence, the social desirability of continuing to use the period 1 precaution in period 2, and of grandfathering, diminishes. To illustrate with the example, I had said that if the new level of harm in period 2 turns out to be $700,000, grandfathering is desirable, for the cost of the new precaution is $20,000, whereas the reduction in expected harm if there is a change to a new precaution is less, $14,000. However, suppose that the old precaution has a scrap value of $10,000. Then the cost of a switch to the new precaution net of scrap value is $20,000 − $10,000 = $10,000, which is less than $14,000, so a change in precaution would be desirable and grandfathering would not be optimal. In general, when there is scrap value, grandfathering is optimal only when the cost of the new precaution minus the scrap value exceeds the marginal reduction in expected harm that would be accomplished by a change to the new precaution.

### 3.3. Transition Cost

An additional assumption that was made in Section 2 was that changing to a new precaution would not involve any cost apart from that of the new precaution itself. Yet in many instances there will be some kind of transition cost because, for instance, a safety device used in period 1 will have to be removed, repairs will have to be made where that device had been installed, or redesign may be needed to make use of a new safety device. Such transition costs obviously enhance the social desirability of continuing to use period 1 durable precautions and thus of grandfathering. In the second illustration, in which the harm learned in

period 2 turns out to be $900,000, I had said that grandfathering was not desirable, as the cost of the new precaution was $22,000, whereas the marginal reduction in expected harm was higher, $27,000. But if there is a transition cost of, say, $8,000, grandfathering would become socially advantageous, since the cost of the switch to the new precaution would effectively be $22,000 + $8,000 = $30,000, exceeding $27,000. If there are transition costs, grandfathering is desirable whenever the cost of the new precaution plus the transition costs exceed the marginal reduction in expected harm that would be accomplished by the change in precaution.

### 3.4. Grandfathering in the Absence of Earlier Legal Standards

In the analysis of Section 2 and in the examples that were discussed, it was socially desirable for parties to take positive precaution in period 1. Furthermore, the argument for maintaining the period 1 precaution and for grandfathering depended on the period 1 precaution being positive. For if that were not so, if no precaution were taken in period 1, then the advantage of adopting a new period 2 precaution would be total, not marginal. If a factory did not install any smoke scrubber in period 1, then the pollution reduction accomplished by installing a new kind of smoke scrubber would be total, not incremental, only in addition to what another smoke scrubber already accomplished. Hence, the factory would be in the same situation as a new factory; its optimal level of precaution would be the period 2 level, and there ought not to be grandfathering.

However, once we take into account the factor of transition cost just discussed, we can see that the basis for grandfathering is restored. In particular, even if no precaution were taken in period 1, a party's having participated in an activity in period 1 may well imply that the party would have to incur a transition cost to undertake a period 2 precaution. For example, if a factory that was built in period 1 did not install any type of smoke scrubber, the factory might find it expensive to install a smoke scrubber in period 2 because that might require renovations. In contrast, a factory that is to be built in period 2 and knows it must install a smoke scrubber can plan for that. Hence, it might be optimal to grandfather, that is, to allow the factory built in period 1 to continue without any scrubber but to require the new factory to install the scrubber. This point is of some relevance because, in reality, we often observe grandfathering when, previously, no legal standard applied rather than when a positive but weaker legal standard applied.

### 3.5. Modification of Property

Now consider the possibility that parties might wish to modify their property for some privately beneficial reason. A factory might want to engage in alterations in order to produce a new good, to make use of a new production technology that would lower its costs, to build a new employee cafeteria—the reasons for modifications are manifold. A modification may affect, and often would lower, the transition costs accompanying a change in durable precautions. Suppose, for example, that a factory must halt production in order to undertake renovations. During that time, a safety device could conveniently be replaced with a new one—whereas if the factory were not shut down on account of renovations, replacing the safety device would itself require cessation of operations. Hence, in this example, the modification would eliminate the transition cost of halting factory operations, for the halt would occur anyway. Another example is where factory modifications require the hiring of architects and engineers. They might charge less to also do the work needed for installing a new safety device than if that were their only task. Against the background of such examples, let us assume that modification lowers transition costs.[20]

To the degree that modifications lower transition costs, modifications will lower the social desirability of continued use of the period 1 precaution and of grandfathering. To illustrate, I discussed in the example of Section 3.4 that, when transition costs are $8,000, grandfathering is desirable, for the cost of the new precaution plus the transition cost is then $30,000, exceeding the reduction in expected harm of $27,000 that the new precaution would bring about. But suppose that a modification would lower the transition costs to $1,000. Then grandfathering would no longer be socially advantageous, for the cost of the new precaution plus the transition costs would be only $23,000. In general, when there is a modification, there should be no grandfathering when the new, lower transition cost plus the cost of the new precaution is less than the marginal reduction in expected harm.

20. It is possible that modifications would affect factors apart from the transition cost that are relevant to the desirability of changing durable precautions. For example, the scrap value could be affected by a modification (it might be easier to remove an old smoke scrubber, in order to sell it, if a factory is being renovated). But the transition cost seems to be the main affected factor, and in any case it would be straightforward to modify what I will say about modifications to take into account their different effects.

### 3.6. Imperfect Information of the State

Another factor that I have not yet considered concerns the information that the state (courts or a regulator) requires in order to determine optimal precautions and thus when grandfathering is desirable. In the basic model of durable precaution, the state needs to know the cost of precautions and the reduction in expected harm that precautions bring about over both periods. Further, when the extensions to the model are taken into account, the burden on the state becomes greater, as it needs to reckon the maintenance cost, scrap value, transition cost, and the effect of modifications on the transition cost.

The state will inevitably suffer from at least some lack of information necessary to the calculation of optimal precautions. As a consequence, it will often have to make decisions on the basis of estimates, perhaps of average characteristics of parties, leading to the possibility of error relative to ideal outcomes. Suppose, for instance, that the state is not able to ascertain the actual transition cost, so the state bases its grandfathering on the average transition cost. In particular, suppose that the state decides to grandfather because the average transition cost is \$15,000, which exceeds the threshold of \$10,000 above which it is optimal to grandfather. Then, if a particular firm happens to face a low transition cost relative to the average, say, its transition cost is \$5,000, the firm would mistakenly be grandfathered by the state. The social cost of such an error is that society forgoes the opportunity to lower the expected harm by more than the average cost of so doing. Under a different scenario, a converse error could occur: a firm could be mistakenly required to change precautions rather than be grandfathered. Suppose that the average transition cost is \$5,000 and the state decides to require all firms to change precautions but a particular firm faces an unusually high transition cost, such as \$20,000. This firm ought to be grandfathered but would not be. The social cost of this type of error is that society requires the expenditure of greater resources than it derives benefits through a reduction in expected harm.

### 3.7. Imperfect Information of the State and Modification

I return here to the subject of modification and grandfathering because of its connection to imperfect information of the state. To explain, suppose that the state cannot easily determine a party's transition cost, which means that the state cannot base grandfathering policy directly on the transition cost. The state might then take the level of expenditures

on modification (modification expenditures) to be an indirect indicator of the transition cost for the reasons given in Section 3.4. In particular, the state might assume that the higher the modification expenditures, the lower the transition cost and thus the less likely grandfathering is to be optimal. Under this view, the state might rationally decide that when a party's modification expenditures surpass a threshold, grandfathering should no longer be permitted.

Although a policy under which grandfathering status is lost if modification expenditures exceed a threshold may thus be good on the whole, it might sometimes result in errors relative to the ideal. Suppose, for instance, that a factory loses its grandfathering privilege under the modification expenditure policy because it spends heavily on a new employee cafeteria, yet suppose that the expenditure on the cafeteria does not really lower the true transition cost associated with a change to a new, less polluting furnace and thus should not have resulted in a loss of grandfathering. Or suppose that a factory does not lose its grandfathering status because it spends only modestly on upgrading its power plant, yet suppose that even this upgrading would have significantly lowered the true transition cost of a change to a new furnace and thus should have resulted in a loss of grandfathering. These examples illustrate the possibility that because modification expenditures may be an imperfect proxy for transition cost reduction, which is what grandfathering status ought to reflect, it is possible for socially undesirable outcomes to occur when grandfathered status depends on modification expenditures.

Another unwanted effect of a policy under which modification expenditures may result in the loss of grandfathering is the socially undesirable curtailment of modifications. The reason is that under the policy, parties have an incentive to keep modification expenditures below the threshold at which they would lose grandfathering status, even though it might be efficient for them to spend more on modifications. Consider the example just mentioned of a factory that could build an employee cafeteria. The cafeteria might be very beneficial for the employees and thus be desirable to add, yet the factory might well not build the cafeteria if that would mean it would sacrifice its grandfathered status.

The detrimental curtailment of modification expenditures together with the problem of erroneous grandfathering decisions constitute implicit costs of the policy under which the degree of modification expenditures determines grandfathering status. Of course, these costs do not

mean that the policy is inadvisable, but they do suggest that there might be significant value in obtaining direct information about transition costs instead of relying on the proxy of modification expenditures.

### 3.8. Justification for Stability of the Law: Second-Best Legal Change in the Absence of Grandfathering

Grandfathering involves administrative costs, for it requires the state to determine whether, or for how long, parties have participated in an activity and have complied with legal rules. Moreover, the problems described in the last two sections diminish the social value of grandfathering. In view of these administrative costs and problems, it may be best for the state not to engage in grandfathering and thus simply to change the law or not to do so for all parties, without inquiry into their past participation in activities and their compliance with legal rules.

Under the assumption that the state does not grandfather, its best decision will reflect a comparison of two types of error cost. If the law is kept stable, the error cost is that from failing to obtain risk reduction from those parties who ought to change their precautions, including from new entrants to the activity. If the law is altered, the error cost is that from forcing those parties to bear the costs of change who ought not to have to adopt new precautions. Whether it is best on net to keep the law stable or to alter it may be viewed as reflecting a comparison of these two types of error cost. The larger the fraction of individuals who engaged in an activity in the past, the more durable and expensive their investments in precautions, the greater the transition costs associated with change, and the less the advantage in adopting new precautions, the more likely it will be that the law should remain stable.

The foregoing constitutes a general justification for the stability of the law. Namely, under broad conditions, modification of the law would result in costs of inefficient forced change for many parties already complying with the law that outweigh, and perhaps greatly, the benefits of modification of the law for new entrants and some past participants.

### 3.9. Participation in Activities and Grandfathering

In the analysis so far, I have taken parties' participation in activities as given—I have presumed that some parties participate in the potentially harmful activity in both periods and that others enter the activity in period 2. How would the analysis of grandfathering be altered if I were to allow parties to decide whether and when to enter into the activity?

In this expanded model, grandfathering would increase participation

in activities because it would reduce the costs of participation. For example, a firm that I had supposed would have entered the harmful activity only in period 2 might now choose to enter in period 1 in order to be able to obtain grandfathered status and operate later in period 2 at a lower cost.

The increased participation in activities due to grandfathering would generally be socially undesirable. As is well known, under a regime of legal standards, parties engage in potentially harmful activities to a socially excessive extent—because they do not have to pay for any harm that they cause provided that they comply with the standards.[21] A firm that installs smoke scrubbers as mandated by pollution regulations does not have to pay for the pollution it still generates and thus might be led to operate even though it should not. This problem of socially excessive participation in activities under legal standards would seem to be exacerbated by grandfathering. Similarly, under strict liability, participation in activities would be optimal in the absence of grandfathering, whereas grandfathering would lead to a problem of socially excessive participation.

The conclusion from the above is that the optimal amount of grandfathering would probably be lower on account of consideration of participation in potentially harmful activities. That is, because grandfathering would increase participation in harmful activities, and because such enhanced participation would tend to be socially undesirable, grandfathering would be socially desirable less often than I found it to be.

## 4. FORMAL ANALYSIS

I here present a formal analysis of most of the content of Sections 2 and 3 of the text. Because the interpretation of the model has been addressed there, I will aim for brevity below.

### 4.1. Basic Model

Risk-neutral parties engage in a potentially harmful activity. The probability of harm in each period depends on the level of precaution in that

21. On the basic problem that the negligence rule (and regulatory standards) fails to moderate adequately parties' participation in potentially harmful activities, see Shavell (1980). As is emphasized there, the problem does not exist under strict liability, for parties must pay for harm due to their activity under that rule regardless of their degree of precaution.

period. The magnitude of the possible harm is not known in the first period, but it is learned before the second-period decision about precautions is made.[22] Let

$x_i =$ the level of precaution in period $i$, $i = 1, 2$; $x_i \geq 0$;
$p(x_i) =$ the probability of an accident in period $i$; $p'(x_i) < 0$; $p'(x_i) \to -\infty$ as $x_i \to 0$; $p''(x_i) > 0$;
$h =$ harm if an accident occurs; and
$f(h) =$ the probability density of $h$ in the first period; $h$ is known in the second period; $h \geq 0$.[23]

Some parties engage in the harmful activity in both periods; others engage in the activity only in period 2.

One assumption that will be considered is that precautions are nondurable (naturally interpreted as modifiable effort to prevent an accident). Under this assumption, the cost of precautions in each period is $x_i$, so the total cost of precautions for a party who engages in the activity in both periods is $x_1 + x_2$; the costs of precautions in each period are independent. If a party engages in the activity only in the second period, its cost is $x_2$.

The alternative assumption is that precautions are durable (naturally interpreted as acquisition of a device to reduce accident risk). In this case, it is assumed that if $x_1$ is the level of precaution that a party takes in period 1 and this is not changed in period 2 (that is, $x_1 = x_2$), then there is no additional cost incurred by the party in period 2, so the cost of precautions over the 2 periods is just $x_1$; but if precautions are altered in period 2, the cost of precautions over the 2 periods is $x_1 + x_2$. (The interpretation of this assumption is that a different level of precaution corresponds to purchase of a device in period 2 that replaces the period 1 device.[24]) If a party engages in the activity only in the second period, its cost is $x_2$.[25]

22. That harm is uncertain rather than that the cost of precautions or their productivity is uncertain is inessential to the main qualitative conclusions. See Section 4.5.

23. It could be assumed that uncertainty about the level of harm is not completely resolved after period 1, but this would not alter the nature of the conclusions.

24. A different formulation would correspond to an interpretation of a change in durable precautions in which the period 1 device is not replaced but enhanced or supplemented in period 2. As was discussed in Section 4.5, the main conclusions about grandfathering would not be different under this assumption.

25. The model of durable precautions and of uncertain harm bears some similarity to models of irreversible investments (because a change in a durable precaution results in its loss) and uncertainty, notably with regard to resource and environmental economics (see, for example, Arrow and Fisher 1974; Dixit and Pindyck 1994, pp. 412–18; Weitzman 2003, pp. 60–65, 139–45). But the emphasis in the latter literature is different: it is on the

### 4.2. Socially Optimal Precautions in the Basic Model

The social goal is to minimize the expected social costs, where social costs are the costs associated with the precautions $x_i$ and of harm caused. For convenience, denote the $x$ that minimizes $x + p(x)h$ by $x^*(h)$; that is, $x^*(h)$ is the optimal level of precaution if $h$ is the harm resulting from an accident in a single-period model in which the cost of precautions $x$ is $x$. Note that $x^*(h)$ is uniquely defined and positive for all positive $h$ and that $x^*(h)$ is increasing in $h$.[26] I will call $x^*(h)$ the conventionally optimal level of precaution for harm $h$.

In the case of nondurable precautions, the social costs for a party engaging in the activity in both periods are $x_1 + p(x_1)h + x_2 + p(x_2)h$. In period 2, when $x_2$ is chosen, $h$ is known, so it will be optimal for $x_2$ to minimize $x_2 + p(x_2)h$. Hence, the optimal $x_2$ is $x^*(h)$. In period 1, when $x_1$ is chosen, $h$ is not known, so the optimal $x_1$ minimizes $x_1 + p(x_1)E(h)$, where $E(h)$ is the expectation of $h$. Thus, the optimal $x_1$ is $x^*(E(h))$. For a party engaging in the activity only in period 2, the social costs are $x_2 + p(x_2)h$, so optimal precautions for that party in period 2 are $x^*(h)$, the same as for a party who had engaged in the activity in both periods. To summarize, we have the following:

Proposition 1. In the case of nondurable precautions, if a party engages in the activity in both periods,

*a*) the optimal precaution in period 1 is $x^*(E(h))$, that is, the conventionally optimal precaution when expected harm given the occurrence of an accident is $E(h)$, and

*b*) the optimal precaution in period 2 is $x^*(h)$, the conventionally optimal precaution when harm is $h$.

*c*) It follows that the optimal precaution in period 2 is different from that in period 1 with a probability of one.

If a party engages in the activity only in period 2,

d) the optimal precaution in period 2 is $x^*(h)$, the same as the optimal

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point that irreversible steps are better not taken until uncertainty is resolved (it is better to refrain from cutting down a forest until it is known how much value it will have to the environment). Here, the emphasis is on what should be done after uncertainty is resolved (whether durable precautions should be changed after the magnitude of harm becomes known).

26. The first-order condition for minimization of $x + p(x)h$ is $1 + p'(x)h = 0$. Because $p''(x) > 0$, the first-order condition determines a minimum, and this must be unique. Implicit differentiation of the first-order condition shows that $x^*(h)$ is increasing in $h$. For any positive $h$, the first-order condition must hold for some $x$, given the assumption that $p'(x) \to -\infty$ as $x \to 0$.

precaution in period 2 for a party who had engaged in the activity in period 1.

Part *c* is true because $h$ will be different from $E(h)$ with a probability of one (only by coincidence would the continuously distributed $h$ turn out to equal $E(h)$).

In the case of durable precautions, consider the optimal $x_2$ conditional on $x_1$. If $x_2 = x_1$, the expected social cost in period 2 is $p(x_1)h$. If $x_2$ is different from $x_1$, the expected social cost in period 2 is $x_2 + p(x_2)h$, so it will be best that $x_2 = x^*(h)$. It follows that if $h$ is such that

$$p(x_1)h \leq x^*(h) + p(x^*(h))h, \tag{1}$$

then it is optimal for $x_2$ to remain at $x_1$; otherwise, $x_2$ should be changed to $x^*(h)$.[27] Condition (1) holds for $h$ in an interval $I(x_1) = [0, b(x_1)]$, where $0 < h^*(x_1) < b(x_1)$ and where $h^*(x)$ is defined as the $h$ satisfying $x^*(h) = x$.[28] The explanation is as follows: if $h < h^*(x_1)$, so that $x^*(h) < x_1$, it would make no sense to change and lower the precaution, since $x_1$ can be maintained as the level of precaution at no additional cost; and as long as $h$ is not too much higher than $h^*(x_1)$, it is not desirable to raise the level of precaution to $x^*(h)$, for that would entail bearing the entire cost of $x^*(h)$, whereas $x_1$ can be maintained for free.

I next describe the optimal choice of $x_1$, denoted $x_1^*$. Social costs as a function of $x_1$ are

$$\begin{aligned} S(x_1) = {} & [x_1 + p(x_1)E(h)] \\ & + [\Pr(I(x_1))][p(x_1)E(h|I(x_1))] \\ & + \int_{b(x_1)}^{\infty} [x^*(h) + p(x^*(h))h]f(h)dh, \end{aligned} \tag{2}$$

where Pr means probability. The first term on the right is the expected social costs in period 1; the second term is the expected social costs if $h$ is in the interval $I(x_1)$, when it is optimal to leave the precaution unchanged at $x_1$; and the third term is the expected social costs if $h$ is

27. For simplicity, I assume that where condition (1) holds with equality, $x_2$ remains at $x_1$, and I adopt similar conventions below without comment.

28. For $h \leq h^*(x_1)$, we know that $x^*(h) \leq x_1$. Hence, $p(x_1) \leq p(x^*(h))$, which implies that condition (1) holds. For $h > h^*(x_1)$ the left side of equation (1) grows faster with $h$ than the right side does, since the derivative of the left with respect to $h$ is $p(x_1)$ and the derivative of the right is $p(x^*(h))$, and the latter is smaller since $x^*(h) > x_1$. Hence, condition (1) does not hold when $h$ is sufficiently large, and $b(x_1)$ is as claimed and is unique.

above the interval $I(x_1)$, when it is optimal to change the precaution to $x^*(h)$. Differentiating equation (2) yields the first-order condition determining the optimal $x_1$,

$$[1 + p'(x_1)E(h)] + [\Pr(I(x_1))][p'(x_1)E(h|I(x_1))] = 0. \tag{3}$$

Note that equation (3) reflects two effects of an increase in $x_1$: the direct effect in the first period and the indirect influence in the second period, that because it will be optimal to maintain $x_1$ for $h$ in $I(x_1)$, there will be a second-period effect as well, which is to lower the expected costs of harm then. (Changing $x_1$ also alters the endpoint $b(x_1)$ of $I(x_1)$, but this has no first-order influence on social welfare.)[29] It follows from equation (3) that $1 + p'(x_1)E(h) > 0$, which implies that $x_1^* > x^*(E(h))$. In other words, the optimal first-period level of precaution $x_1^*$ is higher than it would be were the first period the only concern, for there is a second-period expected payoff as well.

If a party engages in the activity only in period 2, since social costs are $x_2 + p(x_2)h$, it will be best that $x_2 = x^*(h)$. Thus, the precaution here may be different from that of a party who engages in the activity in both periods.

I therefore have established the next result.

Proposition 2. In the case of durable precautions, if a party engages in the activity in both periods,

*a*) the optimal precaution in period 1 is determined by condition (3) and exceeds $x^*(E(h))$, the conventionally optimal precaution for expected harm of $E(h)$;

*b*) the optimal precaution in period 2 remains equal to period 1 precaution $x_1^*$ if harm $h$ is in $I(x_1^*) = [0, b(x_1^*)]$ (that is, if $h$ satisfies $p(x_1^*)h \leqslant x^*(h) + p(x^*(h))h$), but the optimal precaution is the conventionally optimal level $x^*(h)$ if $h$ is higher.

*c*) It follows that the optimal precaution in period 2 is different from the precaution in period 1 with a probability of less than one (equal to that of $h$ exceeding $b(x_1^*)$).

If a party engages in the activity only in period 2,

d) the optimal precaution in period 2 is the conventionally optimal level $x^*(h)$. Hence, the optimal precaution for a new entrant is less than that for a prior participant if $h < h(x_1^*)$, exceeds that for a prior participant

29. That is, the terms obtained by differentiation of equation (2) owing to changes in $b(x_1)$ reduce to zero, since condition (1) holds with equality at this point.

if $h$ is in $[b(x_1^*), b(x_1^*)]$, and is equal to that for a prior participant if $h > b(x_1^*)$.

### 4.3. Optimal Legal Rules in the Basic Model

Having determined optimal behavior, let us discuss how it can be achieved under legal rules. I consider two types of legal rule. Under the first, strict liability for harm, parties are assumed to pay for any harm $h$ that they cause.[30] Under the second, parties' precautions are regulated; I assume that they are required to obey a standard of precaution (and that this is effectively enforced). When a legal rule in period 2 depends on a party's precaution in period 1, I will say that grandfathering applies.

Under strict liability, since a party pays for all harm, a party's private problem is the same as the social problem, so it is clear that a party will choose precautions in a socially optimal manner.

*Remark 1.* Under strict liability, parties will choose socially optimal precautions. In particular, they will do so in both periods, regardless of whether precautions are durable or nondurable, and grandfathering will not be desirable.

Under regulation, presuming that the state has sufficient information to calculate optimal precautions, it can achieve them, so, in view of Propositions 1 and 2, I can state the following.

*Remark 2.* Under optimal regulation of precautions, parties are required to choose optimal levels of precaution. In the case of nondurable precautions, grandfathering is not optimal; precaution in period 2 is $x^*(h)$ whether or not parties engaged in the activity in period 1. In the case of durable precautions, grandfathering may be optimal; parties who engaged in the activity in period 1 are permitted to maintain their precautions at $x_1^*$ unless $h$ turns out to exceed $b(x_1^*)$, whereas parties who enter the activity in period 2 must set precautions equal to $x^*(h)$.

### 4.4. Extensions

I here sketch several extensions of the model of durable precautions (interpreted as devices).

***4.4.1. Maintenance Cost, Scrap Value, and Transition Cost.*** Suppose that if the precaution $x_1$ is kept in period 2, a maintenance cost $m$ will be

30. A fine paid to the state equal to harm, or a corrective tax equal to expected harm, is equivalent to strict liability.

incurred; that if the precaution changes in period 2, the period 1 precaution can be sold for scrap value $s(x_1)$; and that if the precaution changes in period 2, a transition cost $t$ will be incurred (associated, say, with the removal of the period 1 device).

Now reconsider the optimal $x_2$ conditional on $x_1$. If $x_2$ is different from $x_1$, the expected social cost in period 2 will be $x_2 + p(x_2)h - s(x_1) + t$, so it will again be optimal that $x_2 = x^*(h)$. Hence, if $h$ is such that

$$p(x_1)h + m \leqslant x^*(h) + p(x^*(h))h - s(x_1) + t, \tag{4}$$

it will be optimal for $x_2$ to remain at $x_1$; otherwise, $x_2$ should change to $x^*(h)$. Note that if $s(x_1) + m > t$, condition (4) holds less often than condition (1) does. This makes sense, since scrap value and maintenance costs are factors that make keeping $x_1$ less attractive, whereas the transition cost makes keeping $x_1$ more attractive. With condition (4) replacing condition (1), one can determine a revised condition for $x_1^*$ analogous to condition (3), but I will omit the details here (and likewise I will omit discussion of $x_1^*$ below with regard to modifications).

Under strict liability, behavior will be optimal, appropriately reflecting the scrap value, maintenance cost, and transition cost, but under regulation the regulator must take them explicitly into account.

***4.4.2. Modification of Property.*** Suppose that modification of property may be undertaken in period 2 and will yield a private gain for parties (such as a renovation allowing a factory to produce goods at lower cost), where the gain depends on the magnitude of the modification investment. Let $g(k)$ be the gain from modification given the investment $k$, where $g$ is increasing and concave in $k$. Modification is assumed also to result in lowering the transition cost of a change in precaution (such as when a renovation at a factory would allow an opportunity for easier replacement of pollution-control equipment). Thus, let transition cost $t = t(k)$, where $t$ is decreasing and convex in $k$.

Accordingly, social welfare in period 2 is $g(k) - k - p(x_1)h$ if there is grandfathering and $g(k) - k - [x^*(h) + p(x^*(h))h + t(k)] = g(k) - k - t(k) - [x^*(h) + p(x^*h))h]$ if there is not grandfathering.

Given $k$ and thus $t(k)$, grandfathering is socially desirable when

$$p(x_1)h \leqslant x^*(h) + p(x^*(h))h + t(k) \tag{5}$$

(abstracting for simplicity of the maintenance cost and scrap value).

Consider the optimal $k$ and the optimal choice about grandfathering

in period 2. Let $k^*$ maximize the net return from investment $g(k) - k$, so $k^*$ is determined by $g'(k) = 1$. Also, let $k^{**}$ maximize $g(k) - k - t(k)$, the net return from investment minus the transition cost; thus $k^{**}$ is determined by $g'(k) - t'(k) = 1$. It is clear that $k^{**} > k^*$;[31] the reason is that there is a payoff from $k$ in addition to increasing $g$, which is decreasing $t$.

If there is grandfathering, the optimal $k$ is $k^*$, for social welfare given grandfathering is $g(k) - k - p(x_1)h$, and $k^*$ maximizes the first two terms. Likewise, if there is no grandfathering, the optimal $k$ is $k^{**}$, for social welfare when there is no grandfathering is $g(k) - k - t(k) - [x^*(h) + p(x^*(h))h]$.

Hence, to determine whether grandfathering is optimal, we can compare social welfare under grandfathering and $k^*$ to that without grandfathering under $k^{**}$. If

$$g(k^*) - k^* - p(x_1)h > g(k^{**}) - k^{**} - t(k^{**}) - [x^*(h) + p(x^*(h))h], \quad (6)$$

then grandfathering is optimal, whereas if condition (6) does not hold, then grandfathering is not optimal and the optimal precaution is $x^*(h)$.

Note that the optimal solution as just described reflects the following factors. First, the value of modification, due to the gains it yields, may, as a by-product, lower the transition cost enough to make a change in precaution optimal, when otherwise grandfathering would be optimal. If a change in precaution is optimal, then the modification investment should be higher than were its direct gains the only benefit from it, because it also results in a reduced transition cost.

Again, under strict liability, behavior, and thus modifications as well as precautions, will automatically be optimal. Under regulation, the regulator must determine the optimal solution, but note that as long as the regulator determines whether grandfathering is permitted, the parties will be induced to choose the right modification investment: If grandfathering is permitted, parties will of course not spend on a new precaution, and thus will choose $k$ to maximize $g(k) - k$, and so will choose $k^*$; if grandfathering is not permitted, parties will bear $t(k)$, will choose $k$ to maximize $g(k) - k - t(k)$, and so will choose $k^{**}$.

***4.4.3. Imperfect Information of the State.*** For the state to achieve optimal behavior, it must have certain information. Under strict liability, all it need do is observe harm $h$. Under regulation, however, it must be

31. We know that $g'(k^*) - t'(k^*) = 1 - t'(k^*) > 1$. Thus, to satisfy $g'(k) + t'(k) = 1$, $k$ must be raised from $k^*$ (since $g''(k) - t''(k) < 0$).

able to observe the level of precaution taken and to calculate the optimal precaution, which implies that it must know all functional relationships. This situation gives rise to a host of problems that were described in Section 3.5. Hence, for example, suppose that the state cannot observe maintenance cost $m$ and knows only its distribution. Then the state must make a decision about grandfathering on the basis of its knowledge of the distribution of $m$. If the state disallows grandfathering, because $m$ is on average large, it will sometimes make errors, since parties for whom $m$ is small, who should be grandfathered, will have to change their precautions, and so forth.

***4.4.4. Imperfect Information of the State and Modification.*** It is worth taking particular note of the implication of imperfect information with regard to modification of property because of the policy importance of modification and grandfathering. As will be discussed in Section 5, grandfathered status is often removed if the degree of modification is sufficiently large. A rationale for this type of rule is that the magnitude of modification $k$ may serve as an implicit indicator of an unobservable transition cost—with a major modification signaling a low transition cost $t$ and thus a lesser need for grandfathering. However, because high modification investment $k$ results in the loss of grandfathering, such investment may be inefficiently discouraged under the rule.

To demonstrate these points I must modify the model so that there is variation in the levels of modification investment $k$ that parties wish to choose.[32] A natural way to do this is to assume that the productivity of modification investment varies across the population of parties: let the gain from modification investment $k$ be $\theta g(k)$, where $\theta$ is a productivity parameter (a party's type), drawn according to some probability distribution over the positive numbers. Let $k^*(\theta)$ maximize $\theta g(k) - k$ and $k^{**}(\theta)$ maximize $\theta g(k) - k - t(k)$, and note that $k^*(\theta) < k^{**}(\theta)$ and that both are increasing in $\theta$.[33]

The determination of the socially optimal outcome in period 2 is essentially as described in Section 4.4.2. It can be verified that if grandfathering is optimal for parties of type $\theta'$, then grandfathering must be

32. Otherwise the state can, as I noted above in Section 4.4.2, calculate what is optimal for the (identical) individuals and just allow or disallow grandfathering, whichever is optimal.

33 Optimal modification investment $k^*(\theta)$ is determined by $\theta g'(k) = 1$. Implicitly differentiating with respect to $\theta$ gives $g'(k) + \theta g''(k)k^{*\prime}(\theta) = 0$, so that $k^{*\prime}(\theta) = -g'(k) / \theta g''(k) > 0$. That $k^{**\prime}(\theta) > 0$ is shown similarly.

optimal for parties with $\theta < \theta'$.[34] Hence, unless grandfathering is optimal for all $\theta$ or for no $\theta$, there must exist a critical value, say, $\theta_c$, such that for $\theta \leqslant \theta_c$, grandfathering is optimal, and for higher values of $\theta$ it is not. This is the interesting case[35] and is what I will consider. Accordingly, at the optimum, parties with $\theta \leqslant \theta_c$ choose $k^*(\theta)$ and parties with higher $\theta$ choose $k^{**}(\theta)$, so the graph of investment $k$ is increasing in $\theta$, with a discontinuity at $\theta_c$, where it rises from $k^*(\theta_c)$ to $k^{**}(\theta_c)$.

Now assume that the state cannot observe transition cost $t$ and so cannot base grandfathering on $t$ (or on $\theta$, which is unobservable) but can observe modification investment $k$ and base grandfathering on it. The state can select a critical value $k_c$ and allow grandfathering only if $k \leqslant k_c$ and in this way implicitly attempt to mimic the optimum. Given $k_c$, it is clear that parties for whom $k^*(\theta) < k_c$ will choose $k^*(\theta)$ and thus will be grandfathered.[36] Also, parties for whom $k^*(\theta)$ exceeds but is sufficiently close to $k_c$ will choose $k_c$ in order to be grandfathered—in other words, there will be a mass point of parties at $k_c$.[37] Parties with larger values of $\theta$ will not find it worthwhile to choose $k_c$ in order to be grandfathered and will thus choose $k^{**}(\theta) > k_c$. By choosing $k_c$ in a second-best optimal way (close to $k^*(\theta_c)$), the state can approximate optimal behavior, but optimal behavior cannot be achieved, at least because of the massing of parties at $k_c$ who do not invest more (not $k^*(\theta)$) in modification in order to preserve their grandfathered status.

***4.4.5. Second-Best Legal Change and Incentives to Participate.*** What

34. Grandfathering is optimal at a $\theta$ when the analogue to equation (6) holds, namely, when $\theta g(k^*(\theta)) - k^*(\theta) - p(x_1)\,h > \theta g(k^{**}(\theta)) - k^{**}(\theta) - t(k^{**}(\theta)) - [x^*(h) + p(x^*(h))h]$. I want to show that if this inequality holds at $\theta'$, it must hold for lower values of $\theta$. To establish that, it is clearly sufficient to demonstrate that $\theta g(k^*(\theta)) - k^*(\theta) - [\theta g(k^{**}(\theta)) - k^{**}(\theta) - t(k^{**}(\theta))]$ is decreasing in $\theta$. But the derivative of this expression with respect to $\theta$ is (by the envelope theorem) just $g(k^*(\theta)) - g(k^{**}(\theta))$, which is negative since $k^*(\theta) < k^{**}(\theta)$.

35. Otherwise the state can achieve optimality simply by allowing grandfathering or disallowing it for all parties.

36. They are clearly better off at any $k$ grandfathered than not, and because they can choose the optimal $k$ and be grandfathered, they must prefer this.

37. If parties for whom $k^*(\theta) > k_c$ choose $k \leqslant k_c$, they will be best off at $k_c$, given concavity of the objective function and that $k^*(\theta) > k_c$, and their utility will be $\theta g(k_c) - k_c$. If they choose $k > k_c$, since they will not be grandfathered, their best choice of $k$ will be $k^{**}(\theta)$, and their utility will be $\theta g(k^{**}(\theta)) - k^{**}(\theta) - t(k^{**}(\theta)) - x^*(h)$. They will do whichever is better. Now at the value of $\theta$ such that $k^*(\theta) = k_c$, we have $\theta g(k_c) - k_c = \theta g(k^*(\theta)) - k^*(\theta) > \theta g(k^{**}(\theta)) - k^{**}(\theta) - t(k^{**}(\theta)) - x^*(h)$. Hence, it must be true in a positive neighborhood above this value of $\theta$ that $\theta g(k_c) - k_c > \theta g(k^{**}(\theta)) - k^{**}(\theta) - t(k^{**}(\theta)) - x^*(h)$, in other words, that choosing $k_c$ is better than not being grandfathered and choosing $k^{**}(\theta)$ in this neighborhood.

was said in Sections 3.8 and 3.9 is clear and nothing need be added here.

### 4.5. Robustness of the Model

I here discuss why relaxing either of two assumptions that were made in the model would not change the qualitative nature of the conclusions.

The first is the assumption that a durable device must be replaced rather than supplemented. I assumed for simplicity that a durable precaution was a device, such as a smoke scrubber, and that if the precaution were to change in period 2, a new device would be needed and would replace the old device. Thus, I assumed that if the period 2 precaution $x_2$ is different from $x_1$, then $x_2$ needs to be spent in period 2 and the probability of harm is $p(x_2)$. However, another assumption that fits certain situations is that the period 1 device would not be replaced but instead would be enhanced or supplemented with another device. For instance, perhaps a new component can be installed in the period 1 smoke scrubber or perhaps another smoke scrubber can be added so that two smoke scrubbers function to control pollution instead of one. In such situations it is natural to assume, though, that it is less efficient to spend $x_1$ on a period 1 device and then an additional amount $x_2$ to supplement it than to spend the same amount $x_1 + x_2$ at once on a different device. Under this assumption, grandfathering may well be desirable, since the relative lack of efficacy of spending to supplement $x_1$ may make staying put best, even though new entrants spend $x^*(h) > x_1$.[38]

The second is the assumption that uncertainty in the second period concerns the magnitude of harm rather than the technology or cost of risk reduction. If the uncertainty in period 2 concerns the risk-reduction function instead of the harm, it is evident that the main qualitative conclusions reached would not be altered. For example, suppose that in period 2 the probability of harm is given by $p(tx)$, where $x$ is expenditure in that period and $t$ is an uncertain technological or cost parameter. If $t > 1$, then by spending $x$, the effective expenditure would be greater than $x$, so such $t$ correspond to technological advances or reductions in cost.

38. To amplify, the second-period probability of harm might be written as $p(x_1, x_2)$, where $p_2(x_1, x_2) < 0$. In such situations, suppose that $p_2(x_1, x_2) > p'(x_1 + x_2)$, that is, spending an additional dollar in period 2 after the period 1 device is installed reduces risk less than spending that dollar on a better period 1 device. Then it is possible that $-p_2(x_1, 0)h < 1$, so it is not worth supplementing the period 1 device even though $x^*(h) > x_1$.

The choice facing a party in the second period is between not changing the precaution, in which case the risk of harm would be $p(x)$, and changing the precaution and spending $x^*(t)$, the $x$ that minimizes $x + p(tx)h$. Grandfathering is best if $p(x)h < x^*(t) + p(tx^*(t))h$, and the analysis would proceed along the lines that were developed above.

## 5. THE LAW IN THE LIGHT OF THE THEORY

I now discuss briefly certain aspects of the law against the background of the analysis of legal change and past behavior in the preceding sections. I first observe that the law seems to exhibit a general constancy that I see in part as a reflection of the importance of past behavior. I then examine when and how the law employs grandfathering.

### 5.1. General Stability of the Law

Legal rules appear to me to display a significantly greater degree of stability than would be expected were the only argument against change in the law the avoidance of additional administrative costs (that is, the burden on legislators and on courts of considering and of promulgating new rules). If the avoidance of administrative costs were the sole factor favoring legal stability, then legal rules would probably be modified much more often than they are in reality, because added administrative costs are likely to be small in relation to the benefits that even quite modestly altered behavior would bring about for large populations of actors. Were administrative costs the only consideration disfavoring legal change, I believe that all manner of our regulations and legal duties would be amended in a more or less continuous fashion, as advances occur in the technology of risk reduction and as new information about hazards develops.

That legal rules do not change with this frequency I suggest is explained importantly by the fact that individuals and firms make many decisions to take what I have described as durable precautions. In particular, many of their decisions have lasting aspects, such that real risk reduction continues without any, or with only modest, added cost, whereas compliance with new rules would be expensive and effectively squander their prior investments in risk reduction. The reason that parties' decisions tend to have lasting aspects is that the decisions often involve investment in physical capital that is directly or implicitly required by legal rules, or investment in training and intellectual capital,

or investment in financial, contractual, or reporting practices (recall Section 2.2).

Further, in many contexts, it would be costly or impractical for the legal system to take parties' earlier investments in compliance into direct account, determining who made what investments in the past and their present effectiveness, in order to grandfather some of them. Hence, in reality the law must often apply to all parties uniformly and thus either remain the same for the entire population engaged in an activity or change for the whole population (see Section 3.8). For this reason, and in recognition of the parties who have made durable investments in past compliance, it is frequently best for the law to remain fixed even though improvements in technology or new information may seem to call for its modification. Only when a sufficient fraction of the parties who complied in the past ought to change their behavior and satisfy new duties—only when the pressures for change have built to a certain point—will it be socially advantageous for the law to be modified.

### 5.2. Grandfathering as a Feature of the Law

Although, as was just stated, the law tends to exhibit stability, and practical difficulties may prevent the legal system from taking past behavior into explicit account, grandfathering is still a widely encountered aspect of our legal system.[39] Areas in which grandfathering is observed include pollution regulation,[40] land use and real estate zoning ordinances (Anderson 1986, 1:443–681, 3:359–626; 101A C.J.S. *Zoning and Land Planning,* sec. 101 [2005]; Metzenbaum 1955, 2:1210–73), building and safety codes (see, for example, 13 Am. Jur. 2d *Buildings,* sec. 5 [2000]; McQuillin 2004, sec. 24.512; 39A C.J.S. *Health and Environment,* sec. 52 [2003]), licensing of professionals,[41] the enforcement of wills and

39. I am informed by individuals familiar with Continental legal systems that they also employ grandfathering, although they do not use that descriptive term.

40. For a general description and survey of grandfathering and its effects in regard to pollution regulation, see Stavins (2006). He relates grandfathering to, among other legislation, the Clean Air Act (43 U.S.C. secs. 7401–7661 [2000]), the Clean Water Act (33 U.S.C. sec. 1331(a)(1)(B)–(C) [2000]), the Safe Drinking Water Act (42 U.S.C. sec. 300d-9(d)(4)), the Resource Conservation and Recovery Act (42 U.S.C. secs. 6901–92K [2000]), and various state and local mandates. On the effects of grandfathering, see, for example, Becker and Henderson (2000), Bushnell and Wolfram (2006), Crandall (1983), Gollop and Roberts (1983), Gruenspecht (1982), and Nelson, Tietenberg, and Donihue (1993).

41. Many statutes allow grandfathering of old licensees when new requirements are established. See, for example, Idaho Code, sec. 54-213 (2006), which discusses accountants; Ark. Code Ann., sec. 17-28-310 (2006), which discusses electricians; Minn. Stat. Ann., sec. 487.08 (2005), which discusses judicial officers; and Miss. Code Ann., sec. 73-53-7 (2005), which discusses veterinarians.

trusts,[42] ownership of firearms,[43] and immigration status (see, for example, Adjustment of Status to That Person Admitted for Permanent Residence; Temporary Removal of Certain Restrictions of Eligibility, 66 Fed. Reg. 16,383 [March 26, 2001] [to be codified at 8 C.F.R. pt. 245]). Also, as I will suggest below, grandfathering is an implicit feature of the negligence determination under standard tort principles. That grandfathering should be a common feature of the law is, of course, what one would expect in the light of the theoretical analysis presented here and, as has been emphasized, the view that compliance with legal rules involves many decisions with durable aspects. In addition, it is worth noting that the type of grandfathering that we see is what one would predict, in the sense that it focuses on durable forms of compliance, as will be evident, for example, when I discuss some of the specifics of grandfathering with regard to electric utility plants and zoning. To my knowledge, grandfathering is not applied to readily modifiable behavior of parties, such as their driving speed. In other words, at least the gross characteristics of grandfathering are what one would expect in principle.

### 5.3. Tort Law and Implicit Grandfathering

Grandfathering seems to be a latent feature of tort law, owing to the manner in which the negligence rule is likely to be applied. As a general matter, a party will be found negligent for failing to take a precaution that resulted in harm if the cost of the precaution was less than the risk-reduction benefit that it would have generated.[44] In a negligence determination, the risk reduction that the courts would naturally consider I believe to be the reduction from the level of risk that the actor already was accomplishing, and for this basic reason the negligence determination should result in desirable grandfathering. Consider an example similar to that in the Introduction: A refinery had installed device A to reduce the risk of an explosion. This device was state-of-the-art 5 years ago, when the refinery was built, but a new, cheaper device B that is slightly more effective in risk reduction became available last year. If the

42. See, for example, Uniform Probate Code, sec. 8-101 (2001), which discusses provisions for transition; Uniform Probate Code, sec. 2-506 (2001), which discusses execution of wills; and Uniform Trust Code, sec. 1106 (2001), which discusses trust relationships.

43. See, for example, D.C. Ct. R. Ann., sec. 7-2501.01 (2001), which discusses possession of unregistered handguns, and Butterfield (2004).

44. See, for example, the description of the negligence determination in Dobbs (2000, chap. 7) and the discussions in Landes and Posner (1987, pp. 85–88, 102) and Shavell (1987, pp. 19–20).

refinery did not install B last year and as a result an explosion occurred, would a court hold the refinery negligent? It is unlikely, since the court would presumably reason that the additional risk reduction that device B would have accomplished would be minor, given the risk reduction already generated by device A. Yet if the refinery had just been built last year and had installed device A even though B was available at the time, the refinery would be found negligent for not having chosen the safety device that was more effective and cheaper. In other words, the duty of care for a new facility is different from that for an old facility. This illustration shows why conventional application of the negligence rule should tend to lead to grandfathering, even though it would not be described as such.

### 5.4. Regulation of Power Plant Air Pollution and Grandfathering

Electric power-generating plants are an important source of air pollution, responsible for approximately two-thirds of the country's $SO_2$ emissions, a quarter of its $NO_x$ emissions, and two-fifths of its $CO_2$ emissions (see, for example, Reitze 2002, pp. 371–72). These plants are regulated in significant ways under the Clean Air Act of 1970 and amendments to it.[45]

A salient feature of the Clean Air Act is grandfathering: power plants built before 1970 do not face the standards applying to plants built afterward, which are obligated to meet more rigorous, contemporaneous pollution-control requirements. Many of these pre-1970 plants, mostly coal fired, still operate today and are responsible for most of the air pollution generated by power plants (see, for example, Reitze 2002, pp. 384–85; Varadarajan 2003, pp. 2553–54).

Although plants built before 1970 are grandfathered, these plants may have to forfeit their grandfathered status if they are modified. That

45. The Clean Air Act, originally passed in 1963, provided grants to state governments for research and air pollution control programs, acknowledged the danger of motor vehicle exhaust, and promoted emissions standard development for motor vehicles and stationary sources (see American Meteorological Society 1999). The current national air pollution program is based on the 1970 Clean Air Act amendments, enacted the same year that the Environmental Protection Agency was established. Further significant amendments were made in 1977 and 1990 (Pub. L. No. 95-95; 91 Stat. 685; Pub. L. No. 101-549, 104 Stat. 2399). For useful accessible Internet sources on the Clean Air Act, see Environmental Literacy Council (2002), Environmental Protection Agency (2008), and National Resource Defense Council, NRDC Document Bank: Clean Air and Energy (http://docs.nrdc.org/air/default.xdl). Other general sources on the Clean Air Act include Squillace and Wooley (1999), Belden (2001), and Reitze (2001).

happens under certain rules promulgated by the Environmental Protection Agency (EPA) but only if a plant carries out a major modification resulting in a significant increase in regulated pollutant emissions.[46] If a change in a plant does not significantly increase regulated emissions or if the change is limited to routine maintenance, grandfathering status is ordinarily preserved (see, for example, 40 C.F.R. secs. 51.166[a][7], 51.166[b][2]).[47] The definitions and interpretations of a "significant" increase in regulated pollutants and of "major modifications" versus "routine maintenance" are complex and have been the subject of continuing debate and litigation, given their importance to firms because of the financial advantage of sustained grandfathering (see, for example, *Wisconsin Elec. Power Co. v. Reilly,* 893 F.2d 901 [7th Cir. 1990]; *United States v. Duke Energy Corp.,* 278 F. Supp. 2d 619 [M.D.N.C. 2003]; *United States v. Alabama Power Co.,* 372 F. Supp. 2d 1283 [N.D. Ala. 2005]).[48] Whether a modification results in a significant emissions increase varies from pollutant to pollutant (see 40 C.F.R. secs. 51.166[b][23], 51.166[b][39]), and complicated subrules govern the calculation of increases (see, for example, 40 C.F.R. secs. 51.166[a][7][iv][*b*], 51.166[b][3]). Whether a change is major or constitutes routine maintenance depends on whether the change is routine in the industry.[49] Also, under a proposed rule, recently vacated by the courts, whether a change would be considered a modification would depend on whether its cost exceeded 20 percent of the capital costs of replacement

46. For useful overviews of the rules regarding modifications, see Nash and Revesz (2007) and Varadarajan (2003).

47. These features of the regulation of modifications are applicable under the rules of New Source Review in "attainment" areas (where goals under the National Ambient Air Quality Standards have been met), to which I will largely refer in the text. The regulation of modifications is different in nonattainment areas (see Environmental Protection Agency 2007). Moreover, modifications are also governed by the New Source Performance Standards (NSPS), which state in part that an alteration amounting to a "reconstruction" could result in the loss of grandfathered status even if the amount of pollution does not increase. To be a reconstruction, the cost of the alteration must exceed 50 percent of the cost of building a comparable new facility, and meeting NSPS regulations must be technologically and economically feasible (see 40 C.F.R. sec. 60.15[b]).

48. See also Notice of Final Action on Reconsideration, 70 Fed. Reg. 33,838 (June 10, 2005), which summarizes the debate over the rule governing equipment replacement as routine maintenance, and *Clean Air Report* (2006, sec. 14), which summarizes recent court decisions concerning the same.

49. See *Duke Energy Corp* (278 F. Supp. 2d 619) in which the court found that the New Source Review test for determining whether a modification constitutes routine maintenance is whether the modification is routine in the industry.

components (see 40 C.F.R. sec. 51.166[y], vacated by *New York v. Envtl. Prot. Agency* 443 F.3d 880 [D.C. Cir. 2006]).

What can be said about the grandfathering of power plants under the Clean Air Act in the light of the analysis of this article? That there should be some grandfathering of power plants is obviously consistent with the analysis. On one hand, the costs of changing pollution-control methods are often large, involving significant expenditures on durable capital and perhaps alterations of plant design, and on the other hand, the equipment in place already achieves a reduction in pollution, making the benefits of compliance with new control methods marginal rather than total in nature.

Yet the potentially unlimited duration of grandfathering of plants raises questions.[50] With the passage of time, an initial social advantage of grandfathering a plant may diminish and then disappear, for two basic reasons. First, the expenses of maintaining and repairing old plants tend to increase over time, as equipment and buildings degrade. This reduces the cost advantage of grandfathering (see Section 3.2). Second, the pollution-control benefits of changes in abatement methods tend to rise over time, as the technology of pollution-reduction advances. Moreover, it seems that, in fact, the expected harm due to pollution has increased (notably, the greenhouse effect is now widely believed to be serious).[51] These factors increase the marginal payoff from change, such as switching fuel from coal to natural gas. It is of course possible that administrative cost savings could justify an unlimited-in-time grandfathering rule, but given the high social costs of pollution, that does not appear plausible. Hence, it seems that a regime superior to that of the Clean Air Act would limit the duration of grandfathering of power plants or require a showing of evidence for its continuation.

The conditions under which modifications result in the loss of grandfathering also provoke some skepticism. A significant reason is that in important contexts any modification that does not raise the level of pollution is permitted—only modifications that increase pollution may result in the loss of grandfathering. This approach seems mistaken. It could well be that a modification does not increase pollution yet ought to result in the loss of grandfathering status (see Section 3.5) because it

50. Many critics have made points along the lines of this paragraph. See, for example, Nash and Revesz (2007) and Varadarajan (2003).

51. See National Resource Defense Council, Issues: Global Warming (http://www.nrdc.org/globalWarming/default.asp); Union of Concerned Scientists, Global Warming (http://www.ucsusa.org/global_warming).

results in an opportunity to relatively cheaply install up-to-date pollution-control technology, or to change from coal to natural gas, and thereby substantially lower emissions.

Other questions about modifications and grandfathering may also be raised. As I stressed in Section 3.7, modifications are relevant to the decision whether to continue grandfathering especially to the degree that they inform us about the costs of changing to new pollution-control technology; the expenditure or extent of a modification is only a weak indicator of these costs. However, the EPA criteria that determine whether a modification is classified as major do not seem to be closely tied to the costs of changing to new technology (certainly the proposed 20 percent rule mentioned above was not closely tied to these costs).

### 5.5. Regulation of Real Estate by Zoning and Building Codes and Grandfathering

In most areas of the country, real estate is regulated by zoning ordinances, building codes, and related rules, with requirements covering, among many other factors, lot size, setback distances of structures from property lines, percentages of land area covered by structures, height of structures, the safety and adequacy of the design of structures, and the materials and methods of construction (see, for example, Anderson 1986, 1:443–681; Metzenbaum 1955, 2:1210–73; McQuillin 2004; 13 Am. Jur. 2d *Buildings,* sec. 5 [2000]; 101A C.J.S. *Zoning and Land Planning,* sec. 101 [2005]; New York City, N.Y., Zoning Resolution [2006]; New York City, N.Y., Admin. Code, titles 26–27 [2006]; Mass. Regs. Code, title 780 [2002]).

These regulations often include grandfathering provisions. The general nature of the grandfathering is that if a structure was built before the passage of the regulation, the structure is permitted to be noncompliant and without limit of time.[52] Thus, if a setback rule says that

52. See, for example, 101A C.J.S. *Zoning and Land Planning,* sec. 101 (2005): "Since users of land generally acquire rights which cannot be cut off, zoning regulations operate only prospectively, in the absence of special provision to the contrary"; Mass. Gen. Laws Ann, chap. 40A, sec. 6 (2006): "[A] zoning ordinance or by-law shall not apply to structures or uses lawfully in existence or lawfully begun, or to a building or special permit issued before the first publication of notice of the public hearing on such ordinance or by-law"; Bloomington, Ind., Municipal Code, sec. 20.08.01.01 (2003): "Any structure, or any use of land or structure, which does not conform with one or more provisions of this zoning ordinance, but which lawfully existed upon the effective date of the provisions of this zoning ordinance with which the structure or use does not conform, shall be a lawful nonconforming use or structure."

buildings must be at least 50 feet from roads, but a building that was constructed beforehand is only 30 feet from a road, the building will not ever have to be moved or demolished in order to comply. Still, not all regulations include grandfathering provisions, and, notably, rules bearing on safety and health often do not.[53] For instance, certain requirements regarding septic tank hookup to sewer systems, safety fencing, and signage must be adhered to by all parties.[54]

A grandfathered structure may lose its grandfathered status if modified. A typical rule would disallow continuation of grandfathering if the cost of the modification exceeded a percentage, such as 50 percent, of the value of the structure (see 83 Am. Jur. 2d *Zoning and Planning*, sec. 605 [2003]).[55]

The grandfathering of real estate as just summarized seems broadly consistent with the analysis of this article, as is illustrated by setback regulation. A home that is only 30 feet from a road, instead of 50 feet as required by a zoning rule, presumably would be very expensive to move; the cost would be at least in the tens of thousands of dollars. The social benefit of having a greater setback is probably largely aesthetic and much lower than the cost of moving the home. If so, the grandfathering of a noncomplying setback would be socially sensible, and

53. See McQuillin (2004, sec. 24.512, note 43): "[A]ccording to considerable authority, building codes or ordinances, or certain of their provisions may be made applicable to existing buildings. . . . The question in these cases is whether the public welfare demands retroactive application and whether the property owners affected suffer unreasonable exactions as compared with the resulting public benefits. Thus, provisions relating to repairs, reconstructions, and alterations thereafter to be made, or requirements for the protection of health and lives of persons occupying buildings may be made applicable to existing structures."

54. See, for example, *Renne v. Township of Waterford* (252 N.W.2d 842 [Mich. Ct. App. 1977]), which affirms the judgment that septic tank users must forgo using their septic tanks and pay for connecting to a new sewer system; *Town of Hempstead v. Goldblatt* (9 N.Y.2d 101, 172 N.E.2d 562 [1961], which requires compliance with a local ordinance providing for safety fencing, setbacks, degrees of slope, barricades, lights, retaining walls, and maximum groundwater level before continuing sand pit operation; *Lyman G. Realty Corp. v. Gillroy* (172 N.Y.S.2d 907 [App. Div. 1958], ruling that the company must obtain a permit to maintain its roof sign, even though the sign was constructed before the sign-safety-promoting permit requirement was enacted.

55. See also, for example, *Marris v. City of Cedarburg* (176 Wis.2d 14, 498 N.W.2d 842 [1993]), which considers a claim that property had lost its grandfathered nonconforming status because of alterations, as defined by city ordinance, that exceeded 50 percent of the property's assessed value; *Marcus v. Village of Mamaroneck* (283 N.Y. 325, 328, 28 N.E.2d 856, 858 [1940]), which features a local ordinance according to which "no existing building devoted to a non-conforming use may be altered at a cost for the alteration of a sum exceeding fifty percent of the assessed value of the lot and building."

similar observations apply to many other regulated aspects of real estate, such as building dimensions and height. At the same time, the exceptions to grandfathering also display a rough rationality. Requiring sewer hookup, even by existing septic tank users, may make economic sense (connection costs are relatively low and long-term benefits may be substantial) and likewise for installation of safety fencing and removal of dangerous signs (the costs are not great and the benefits of compliance are large, especially because they involve enhancement of personal safety).

That the grandfathering that we observe is typically indefinite in duration also seems explainable. The passage of time is not likely to change greatly the high cost of changing the location or physical characteristics of structures, or of lot size, nor is it likely to alter substantially the lower and often modest aesthetic benefits of compliance. (Note the contrast between this conclusion and the opinion discussed above that grandfathering of power plants should be of limited duration, because both the costs of noncompliance and the incremental benefits of compliance with pollution regulation rise over time.)

Finally, that modifications may result in the loss of grandfathering status if their cost surpasses a threshold is understandable for the general reasons explained in Section 3.7. For example, a major renovation of a home may provide an opportunity to cheaply bring wiring up to code requirements, since walls are likely to be opened up, electricians, carpenters, and painters are likely to be working on site, and the like. Of course, this is not to say that the percentage criterion cannot be improved, perhaps made dependent on the nature of the noncompliance. Also, it is possible that when a modification is made, its expense should not be examined, but rather the direct approach should be pursued of estimating whether and how much the cost of compliance (like that of bringing wiring up to code) really does change as a consequence. The problem with this direct approach is its high administrative expense in relation to that of use of the modification expenditure threshold, and thus it may well be inadvisable. (Note again the contrast with the case of power plants, where incurring the administrative cost of the direct approach might be justified by the magnitude of the costs and the benefits of optimal regulation of each single power plant.)

## 6. RELATED VIEWS AND LITERATURE

I comment here on the general notion that the law ought to be stable because it is relied on, the literature concerning legal transitions, and economically oriented writing on optimal legal rules.

### 6.1. Parties Rely on the Constancy of Legal Rules

A frequently expressed view is that it is generally socially desirable for legal rules not to change unduly, because parties make their plans in reliance on the existing set of rules.[56] The rationale given here for the stability of legal rules is consistent with that view. As has been the major theme of this article, if parties rely on present legal rules and comply with them by making required durable investments (broadly interpreted—recall Section 2.2), then it will often be socially desirable for their legal duties not to change. The reason is that a change could be inefficient (a new smoke scrubber or a new method of overhauling an aircraft engine might cost more than the incremental gains it would achieve over the present scrubber or method). It follows that keeping the law fixed may be desirable when, as would often be so, explicit grandfathering is not feasible, as was discussed in Section 3.8. In other words, stability of the law may be socially advantageous because it avoids forcing many parties to inefficiently alter the durable investments that they had made in compliance with the law.

The foregoing rationale for the stability of legal rules is not, however, the instrumental justification that I believe most of its proponents have in mind, which is that participation in activities would be undesirably chilled if legal standards might be raised in the future.[57] This argument is problematic. It is true that participation in activities will be discouraged if there is a risk that legal standards would become more rigorous, but it is not true that such a reduction in participation in activities is likely to be socially undesirable. As was noted in Section 3.9 and as is well understood, participation in potentially harmful activities tends to be socially excessive under a regime of legal standards (because parties do not have to pay for harm done given compliance with the standards). Hence, although the level of participation in activities will be reduced

56. See footnote 3.

57. There is also a commonly encountered noninstrumental justification for the stability of law: individuals expect the law to be stable; it is undesirable per se to upset parties' expectations; hence the law should be stable. For this justification to apply, it must be explained why individuals expect the law to be stable, either in fact or in theory. Thus, whatever may be its merits, the justification is incomplete.

if parties have to adhere to increases in legal standards, the level of participation will still be too great from a social perspective, assuming that the legal standards are properly chosen.[58]

### 6.2. Literature on Legal Transitions

Beginning with Graetz (1977), a literature has developed on whether legal relief from the burdens of legal change may be socially desirable to grant (see, for example, Fisch 1997; Kaplow 1986; Kempler 1984; Levmore 1998, 1999; Logue 2003; Quinn and Trebilcock 1982; Shaviro 2000; Troy 2000). This transitions literature originally emphasized tax law but reached broader conclusions, especially in Kaplow (1986), notably that grandfathering is a generally undesirable policy (Graetz 1977, pp. 68–73, 87; Kaplow 1986, pp. 584–87).[59] The nub of the argument made in the transitions literature against grandfathering is that it interferes directly with the social purposes of change in legal rules, because by its nature grandfathering protects parties from having to obey socially desirable changes in rules. Grandfathering is also thought to undermine social welfare indirectly because if parties are shielded from future changes in legal rules, they will not be induced to plan their present actions keeping in mind the possibility that subsequent change in their actions might be socially desirable. The only potentially valid basis for grandfathering discussed in the transitions literature is as an implicit form of insurance against losses suffered when legal rules change. But the literature argues that grandfathering would be an inefficient form of insurance and also that parties who desire insurance should seek to purchase it on private insurance markets.

How can the negative conclusion about grandfathering in the transitions literature be reconciled with the conclusion developed here that grandfathering is often socially good? The key to understanding the difference in conclusions is to note that the transitions literature does not distinguish between legal rules based on legal standards and legal rules based on strict liability. Let me examine the criticisms of grand-

58. This is not meant to deny that if legal standards are revised without proper basis, parties' motives to participate in activities could be undesirably dulled.

59. There are many differences in position among these and other authors in the transitions literature on the demerits of grandfathering, but there is no need for me to distinguish them for my purposes.

fathering made in the transitions literature under each of these two major forms of legal rules.[60]

In the case of rules based on legal standards, does grandfathering interfere directly with socially desirable legal change? Self-evidently it does not, because, by the design of the regulators, grandfathering is granted to a party only when requiring the party to alter its behavior would be socially undesirable. A firm will be grandfathered and permitted to continue using its old smoke scrubber only when switching to a better smoke scrubber would be socially undesirable (because the cost of the new scrubber would exceed the marginal benefit it would yield). Conversely, a firm will not be grandfathered whenever it ought to replace its old smoke scrubber with a better one. Hence, grandfathering does not result in direct interference with socially desirable changes in precaution, and grandfathering may be needed to prevent socially undesirable changes in precautions. Moreover, there will generally be many circumstances in which changes in precautions are socially undesirable, and thus in which grandfathering is called for, because of the durability of many precautions.[61]

Continuing, does grandfathering reduce social well-being indirectly, because it means that parties' present behavior will fail to anticipate properly possible future changes in the law? Again, the answer is no. In the first place, parties' present behavior is by hypothesis regulated—it must satisfy a legal standard; it is not behavior that parties are free to choose and thus that could be influenced by anticipated future changes in the law. The smoke scrubber that a firm installs today is not one that the firm is free to choose; in a regulated world, the scrubber must be of the type prescribed by the regulators.[62] Furthermore, by the design of

60. I will not address the criticism concerning provision of implicit insurance as a rationale for grandfathering. The reason is that issues of insurance have no relevance to the rationale for grandfathering that I have advanced in this article. However, I happen to agree that grandfathering should not be adopted in order to provide implicit insurance to those who would lose as a result of legal change. And I also agree that financial relief (which could be distinct from grandfathering) generally ought not be given as a form of insurance for a change in legal policy, owing to the existence of private insurance markets.

61. In the transitions literature, it seems to be assumed, at least implicitly, that a change in a legal rule is socially desirable for all parties. Here, as the reader knows, that is not assumed, and indeed the major question addressed is whether a legal change that is desirable for new entrants to an activity is desirable for those already engaging in the activity and complying with a past legal standard.

62. Of course, in reality, the regulated world is more complicated than I just described it to be, and some dimensions of behavior affecting risk are not effectively controlled by regulation. Grandfathering could affect decisions about such dimensions of behavior. For

the regulators, present regulated behavior will in principle appropriately reflect all possible future changes in the world. In the model that I examined, for example, the level of precaution chosen by the regulators to be the legal standard in period 1 impounds correctly all possible future changes in harm in period 2.[63]

Now let us turn to rules based on strict liability. Here the criticisms of grandfathering made in the transitions literature do apply. That is, were parties protected against having to pay for changes in the harm that they might cause in the future, they might not take appropriate precautions later, and they might also take inadequate precautions today. But these criticisms of grandfathering are of a piece with mine. Recall (see Section 2.4) that I also said that grandfathering is undesirable under strict liability because grandfathering would dilute the level of precaution taken to alleviate the risk of harm.

It is interesting to observe that the foregoing point, that grandfathering is undesirable when liability is strict, bears on the evaluation of grandfathering in the area of taxation, to which the transitions literature was initially directed. In that domain, there is good reason to think that grandfathering is socially undesirable, because taxes often have strict-liability aspects. To illustrate where this is almost literally true, suppose that a tax rule is designed to reduce pollution and that the tax is set equal to the expected harm caused by polluting activities. If new information emerges indicating that pollution is more harmful than had been thought, one can readily show that it is socially desirable for the tax to be increased commensurately, so that, in particular, there should be no grandfathering in the form of retention of the old, lower tax for parties who had been paying only that. Of course, many taxes have a purpose different from a corrective pollution tax and are designed to raise revenue, but I believe that arguments similar to those applying under strict liability would frequently be valid with respect to them.

To conclude, my assessment of the transitions literature is that its

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example, as I explained in Section 3.9, grandfathering might lead parties to enter into regulated activities more often than they otherwise would. However, such observations should not distract us from the central point under discussion that there can be no incentive effects of grandfathering on regulated dimensions of behavior because, by definition, they are controlled by the state.

63. In Section 2.3 I explain informally how the optimal precaution in period 1 depends on the array of possible outcomes in period 2, and in Section 4.2 I explain this formally. In particular, condition (3) of Section 4.2 determines the optimal level of durable precaution $x_1^*$ in period 1, and this condition involves the entire distribution of possible future harms through the terms $E(h)$, $\Pr(I(x_1))$, and $E(h \mid I(x_1))$.

fundamental criticisms of grandfathering have relevance mainly in the context of strict liability and probably also of taxation. In the domain of law governed by legal standards, the criticisms of the transitions literature are misplaced. In that domain, which comprises the great majority of our legal rules, the benchmark for thinking should be that grandfathering is sometimes socially desirable, for the reasons elaborated in the analysis of this article.

### 6.3. Economically Oriented Literature on Legal Rules

There exists, of course, a well-developed economic literature on optimal behavior to prevent harm and the inducement of that behavior through the use of legal rules. This literature generally views parties as choosing precautions on a blank slate—past behavior is not considered.[64] Hence, what the present article contributes to the economic analysis of legal rules and optimal behavior is the examination of the influence of past behavior on presently optimal behavior and the implications of this dependence for the design of legal rules.

## 7. CONCLUSION

I have considered here the general question whether, and how, legal rules should change in the light of new circumstances and conditions. The main point of emphasis has been that the steps that are socially desirable for parties to take depend on their past actions when those actions have durable aspects. This gave rise to the conclusion that it is often undesirable for parties to make changes, even though a new entrant into a regulated activity ought to take previously unrequired actions. And what flowed from that conclusion was that grandfathering may be desirable or else, if grandfathering is infeasible, that it may be best for legal duties not to be altered.

The issues addressed here seem to me to be important to a consideration of legal change because of my empirical judgment that much of our behavior that is regulated by law displays significant durable aspects.

64. The paradigm for the use of legal rules to channel behavior desirably is that developed in the literature on the economics of tort law, on which see generally Calabresi (1970), Landes and Posner (1987), and Shavell (1987); these sources do not take past behavior into account in discussing later optimal behavior. Likewise, recent surveys of the economics of liability omit mention of the relevance of past behavior to subsequent optimal behavior; see, for example, Brown (1998).

Hence, explicit recognition of that point in the analysis of legal change should be included in our intellectual agenda.

Also, one hopes, the analysis offered here may help to clarify thinking and possibly to offer guidance to policy makers and courts. In this regard, I suggested that legal authorities could improve the rules determining whether modifications result in the loss of grandfathered status under the Clean Air Act. Moreover, legal authorities could avoid the whole task of policing modifications and grandfathering by adopting the rule of strict liability or by employing pollution taxes. As I explained, under this type of rule, legal authorities eliminate in a fell swoop the entire need to consider past behavior in their decisions; private actors themselves are induced to take their past behavior into proper account with no oversight from without.

Last, let me comment on the positive aspect of the analysis of this article. I have suggested that the fact that we observe grandfathering and, more generally, a certain measure of stability in the law, is in substantial respects explained by the central point of the analysis here, namely, that the expense of legal change may not be worth the incremental benefits over what society obtains from past compliance with legal rules. What I have not examined, however, is doubtless a significant part of the explanation for grandfathering. Namely, grandfathering is in the selfish interest of incumbents in an activity, especially of firms in an industry, and allows them to benefit without appearing to stand in the way of legal change. Quite apart from the social desirability that grandfathering may possess, then, grandfathering enjoys a type of political and economic appeal for incumbents that may help to explain why we have as much grandfathering as we do, and perhaps too much.

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