Statutes versus Enforcement: The Case of the Optimal Speed Limit

PHILIP E GRAVES, University of Colorado at Boulder
DWIGHT R LEE, University of Georgia
ROBERT L SEXTON, Pepperdine University
Statutes Versus Enforcement: The Case of the Optimal Speed Limit

By Philip E. Graves, Dwight R. Lee, and Robert L. Sexton*

An important literature has evolved which considers the optimal tradeoff between the probability and magnitude of fines (see Gary S. Becker, 1968, A. Mitchell Polinsky, and Steven Shavell, 1979). The conclusion of this literature is that, under risk-neutrality, efficiency dictates that the probability of catching an individual engaging in an externality generating activity should be set as low as possible, while the fine should be as high as possible (limited only by the wealth of the perpetrator).

Similar considerations apply to the setting of statutes versus enforcement activity although we shall return to caveats to this approach in concluding remarks. There have been occasional cases where at least implicit tradeoffs apparently have been made, such as the $1,000 fines for littering (recently raised from $500 in many states, though scarcely ever enforced). Such cases are, however, usually consigned to activities generating externalities that are difficult or impossible to effectively enforce in any event. In the more general case, those setting standards seldom consider enforcement efforts, perhaps tacitly assuming full compliance. We consider here some implications of the separation of statute setting and enforcement efforts for the topical issue of establishing highway speed limits in Section I, while more general social implications close the paper in Section II.

I. Statutes, Enforcement Effort, and Average Speed

In assessing the benefits from lowering the speed limit, Charles A. Lave (1985) argues that it is not the reduction in average highway speed that generates the major benefit, but the reduction in its variance (see also Thomas Forester et al. (1984) and David T. Levy and Peter Asch, Donald Snyder, and Richard Fowles and Peter D. Loeb (in this Review)). Recognizing the possible importance of variations in speed on highway safety would seem to push in the direction of reducing the speed limit, although as seen below, this is not necessarily the case.

We begin with a model in which reductions in accident externalities come entirely from reductions in average highway speed, then discuss implications of extending the model to allow accidents to depend on speed variance. The crucial feature of this model comes from the recognition that average highway speed, $S$, is a function of both the speed limit, $L$, and the level of policing, $P$, given by $S(L, P)$. Over relevant ranges of $L$ and $P$, it is reasonable to assume that $S$ increases at a decreasing rate with respect to $L$ and decreases at a decreasing rate with respect to $P$:

$$S_1 > 0, S_{11} < 0, S_2 < 0, S_{22} > 0.$$  

*Department of Economics, University of Colorado, Boulder, CO 80309, Department of Economics, University of Georgia, Athens, GA 30601, and Division of Social Science, Pepperdine University, Malibu, CA 90265, respectively. We are indebted to anonymous referees for emphasizing caveats to the approach taken here and for expository improvements.

*Even the argument regarding average speed may be dubious: after an initial sharp decline in death rates between 1973 (55,000) and 1974 (46,000), the 55 mile-speed limit came to be viewed as a safety measure rather than an energy-saving measure. However, during the 1980s death rates have continued to fall (especially on interstates) even though average driving speeds have risen. Other factors are probably at work, obscuring the safety benefits of lower speeds, although in the absence of a controlled experiment, this is speculative.

*Obviously the magnitude of these partials will depend upon the severity of the penalties imposed on
The private net benefit realized from the average highway speed is given by the function \( B(S) \). Since the purpose of a speed limit is to keep motorists from traveling as fast as they otherwise would, it is assumed that \( B'(S) > 0 \) over the relevant range of speed, with \( B''(S) < 0 \). The cost of accident externalities, \( C(S) \), is given as a function of average speed only, with \( C'(S) > 0 \) and \( C''(S) > 0 \). It is assumed that the marginal and average cost of policing is given by the positive constant \( \theta \). Finally, it is assumed that there is some speed \( L \) below which it is politically impossible to lower the speed limit.

The recent legislative activity raising certain speed limits suggests that 55 miles/h may well be at or below \( L \). In terms of the introductory discussion \( L \) may alternatively be thought of as the speed limit set by the legislature (perhaps on energy-use grounds) without regard to enforcement.

We are now in a position to express the objective of speed limit policy as solving for the \( L, P, \) and \( \lambda \) which maximizes:

\[
Z(L, P, \lambda) = B[S(L, P)] - C[S(L, P)] - \theta P + \lambda (L - \bar{L}).
\]

The Kuhn-Tucker solution to this inequality constrained maximization problem is:

\[
\frac{\partial Z}{\partial L} = [B'(S) - C'(S)] S_1 + \lambda \leq 0,
\]

\[
\frac{\partial Z}{\partial P} = [B'(S) - C'(S)] S_2 - \theta = 0,
\]

\[
\frac{\partial Z}{\partial \lambda} = L - \bar{L} \geq 0,
\]

\[
(1 - C'(S)) S_1 + \lambda \geq 0,
\]

\[
(1 - C'(S)) S_1 + \lambda L = 0,
\]

\[
\lambda (L - \bar{L}) = 0.
\]

The intuition behind these conditions is straightforward. Condition (3) calls for an increase in policing until its marginal value, \( [B' - C'] S_2 \), is equal to its marginal cost, \( \theta \). Since \( \theta > 0 \) and \( S_2 < 0 \), it follows from (3) that \( B' - C' < 0 \). This, along with the fact that \( S_1 > 0 \), means that (2) holds as a strict equality in light of equation (6); hence the marginal value of increasing the speed limit is negative. This implies that the advantage that could be realized if the speed limit were reduced is being frustrated by the constraint \( L \geq \bar{L} \) and, therefore, \( L = \bar{L} \). (Note that \( \lambda \) is strictly positive from (6), hence \( L - \bar{L} = 0 \) from (7)). It is interesting to note that in this case the optimal speed limit is completely independent of the functions \( B(S) \) and \( C(S) \), with only the amount of policing being affected by the benefits or costs associated with highway speed.

The solution conditions (2) and (3) are diagrammed in Figure 1. The curve \( MV(P; L) \) represents the marginal value of those detected in violation of the speed limit. For example, the fine for going 65 miles/h is $5 in Montana (with no points assessed) while in Maryland the fine would be $40, with points (see Newsweek, July 21, 1986, p. 15, for information on other states). In order to focus attention on the policy variables \( L \) and \( P \), the penalty structure will be assumed fixed throughout the analysis, ignoring regional variations. The sign on the cross partial \( S_1 S_2 \) will also be of significance. Since an increase in \( L \) will find more motorists obeying the speed limit voluntarily, it is reasonable to assume that increasing \( L \) will reduce the negative effect an increase in \( P \) has on \( S \), or \( S_1 < 0 \) and \( S_2 > 0 \).

We let \( \bar{L} \) be sufficiently low so that if a speed limit of \( \bar{L} \) were perfectly enforced the result would be an average highway speed of \( S \), \( S < \bar{L} \), where \( B'(S) - C(S) > 0 \).

In this formulation, we impose the inequality constraint that \( L \geq \bar{L} \), but not a corresponding nonnegativity constraint on \( P \). This appears plausible in that if \( P \) were not strictly greater than zero, motorists would realize that any speed limit is meaningless and would react by returning to the private outcome which ignores external costs. Hence the optimal \( P \) value will involve an internal solution.

The sufficient conditions are satisfied by the earlier restrictions.
policing the speed limit \( \bar{L} \), or

\[
(8) \quad MV(P; \bar{L}) = B'(S(L, P)) - C'(S(L, P))
\]

This marginal value is positive over some initial range of policing, but since perfect enforcement of speed limit \( L \) would result in \( B' - C' > 0 \) (see fn. 3), \( MV(P; \bar{L}) \) will become negative if policing is increased to a sufficiently high level. Continued increase in \( P \) will eventually find the \( MV(P; \bar{L}) \) curve sloping upward and approaching zero asymptotically since one would expect that \( S_2 \to 0 \) as \( P \to \infty \) and full compliance is realized. In accordance with condition (3), the optimal level of policing is given by \( \bar{P} \), where \( MV(P; \bar{L}) \) intersects the horizontal line at \( \theta \). It should be noted, since \( B' - C' < 0 \) under the optimal policy, that the average highway speed will be higher than that which satisfies the conditions conventionally thought to determine the optimal average speed, or \( B' - C' = 0 \).

If any attempt to reduce the highway speed limit below 55 miles/h would encounter overwhelming political resistance (as suggested by the successful recent efforts to raise that limit on rural interstates), then it is the case that \( L = 55 \) miles/h. Therefore, according to the model just developed, the nationwide speed limit of 55 may well be optimal.

The plausibility of this result, in the context of the present model, comes from recognizing that of the two ways to reduce current average highway speed, lowering the speed limit or raising the level of policing, the former will have, on the margin, lower social costs than the latter. This is akin to substituting harsh penalties for costly detection efforts in the control of crime, as discussed by Becker (1968).

The impact of speed variance, in the present setting which emphasizes enforcement costs, is interesting and potentially perverse. Lave (1985) argues that a reduction in the speed limit makes its largest contribution to highway safety by coordinating (decreasing the variance of) highway speeds. As discussed more formally in Dwight Lee, Philip Graves, and Robert Sexton (1987), incorporating the impacts of speed variance in the present model is capable of implying that the optimal speed limit in the wide-open western states (for example, Montana) may be lower than in the more congested eastern states (for example, Maryland).

To clarify, consider the extreme case where speed variance is the sole culprit in lowering highway safety and that, on other grounds (perhaps foreign energy dependence), desired average speed were the same in Montana and Maryland. Stringent enforcement of the speed limit in Maryland—to reduce variance, which matters more there—would have the additional impact of lowering the average speed below the optimum. Hence, under these circumstances, the posted speed limit would optimally be set higher in Maryland to offset the impact on the average speed of the optimally greater enforcement to reduce variance! This seemingly perverse result need not, however, occur if the optimal average speed in Montana were enough greater than in Maryland.

The model developed in this section puts a different perspective on the cost-benefit stud-
ies that conclude that the 55 miles/h speed limit is too low but that ignore the role of policing costs (see, in addition to those already cited, Gilbert Castle (1976), Charles A. Lave (1979), and James Jondrow et al., 1983). The conclusion of these studies is that the average highway speed is too low under the 55 miles/h limit. This conclusion is consistent with the present model, which calls for an average highway speed even greater than that typically considered to be socially optimal. But in the present context, evidence suggesting that highway speeds are too low under the 55 miles/h limit is not an argument for increasing the speed limit. Rather it argues for reducing the amount of policing used to enforce the speed limit.

II. Conclusions

The tradeoff between statute setting and enforcement efforts is not limited to the choice of statutory speeds. All regulations require enforcement if they are to be effective; nevertheless, most economic analysis proceeds as if somehow regulations are self-enforcing. This can lead to policy conclusions that are questionable. It can also result in a failure to uncover implications that are of interest quite apart from specific policy concerns. Policy approaches to several recent social issues can benefit from the observations here. In the past few years drunken driving has been of increasing concern in this country. An approach to this problem analogous to the setting of speed limits discussed here would be to define “drunk driving” as occurring when blood alcohol levels exceed, say, 0.05 rather than the current 0.10 to 0.15. This redefinition would no doubt reduce the average level of blood alcohol observed among drivers in this country as it has in Scandinavia where, as an extreme, one country does not allow a positive blood alcohol reading. Juvenile crime could similarly be reduced, without the use of additional scarce resources, by redefining “juvenile” to be a lower age than at present. Other examples will no doubt occur to the reader.

Some objections to the approach taken here, and indeed to that of Becker and others, should be raised at this point. First, issues of equity emerge: a lower speed limit with less enforcement to obtain the same average speed would mean that there would be more violators of the posted speed, each having a lower probability of being caught. This might engender considerable sympathy for those arbitrarily singled out for punishment. In the extreme, a speeding or DWI arrest could become viewed as “cruel and unusual punishment.” Moreover, a mistaken conviction (while no doubt much less likely than at present) would be received with great resentment. Similarly, relying extensively on this approach could turn a majority of our citizens into law-breakers, perhaps leading to reduced self-policing behavior on their part. There is the related legal presumption, partially questioned here, that laws without enforcement are meaningless, indeed counterproductive if they result in negative externalities to more general law-abiding behavior. Clearly, pure statutory changes are not costless up to the point of overwhelming social opposition. Finally, in the specific context here, the rapid development of enforcement technology (for example, photographic techniques) also softens the policy implication. To the extent that these criticisms are valid, they reduce the quantitative significance of the point being made here. The impact of the current separation of statute-setting from enforcement does, however, leave this point qualitatively unaffected. Indeed, as already indicated, large litter fines are virtually never enforced but probably do contribute to litter reduction, yet much of the preceding criticism could be leveled at litter laws. However such objections might suggest that great caution be exercised in moving to a revised legal system in which the tradeoff between statute stringency and enforcement is fully exploited.

REFERENCES


Castle, Gilbert, “The 55 MPH Speed Limit: A Cost-Benefit Analysis,” Traffic Engineer-


