Taxes Versus Legal Rules as Instruments for Equity

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TAXES VERSUS LEGAL RULES AS INSTRUMENTS FOR EQUITY

A More Equitable View

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ABSTRACT: Kaplow and Shavell (1994) show that legal rules should not be made contingent upon the income (wealth, consumption, occupation, etc...) of the parties and conclude from this that "it is appropriate for economic analysis of legal rules to focus on efficiency and ignore the distribution of income." We accept the validity and importance of their argument against conditioning legal rules on these otherwise taxable attributes. But we argue against their apparent conclusion that legal rules should be set according to efficiency considerations alone.

Using a slight modification of their own model, we find that: 1) even in the presence of an optimal income tax, <u>any</u> concern for equity dictates that legal rules deviate from efficient standards in a manner that aids the less well-off—this, so long as there is <u>any</u> heterogeneity in the way that agents respond to the legal system; 2) when, in addition, income differences are predominant in overall inequality, legal rules should in fact be adjusted away from efficient standards in a manner that helps low-income individuals; 3) under certain additional conditions, legal rules should be specifically adjusted to correct income-based inequality—legal rules should not be made contingent on parties' income on a case-by-case basis, but they should be adjusted across the board in a manner that counteracts income inequality.

Our broader point is that there is no <u>a priori</u> reason to favor any one economic activity over another—leisure choice over care choice, for instance—in accomplishing redistributional goals. The optimal redistributional program will involve a mixture of methods and deviations from efficiency in one domain may even be used to correct inequalities arising in another. We conclude that the extent to which legal rules should be used for redistributional purposes must be settled empirically and/or on the basis of factors outside the scope of Kaplow and Shavell's (1994) analysis.

JEL: K00, K34, K13, H21, H23

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What role should equity play in structuring legal rules? A recent and already influential paper by Kaplow and Shavell (1994) ["KS"] adds an important new insight to this age-old debate. KS argue that courts should not alter legal rules away from efficient standards by conditioning on parties' incomes (or, more generally, their wealth, consumption, occupation, etc...). However strong one's concern for equity, any redistribution of income affected by distorting legal rules can be more efficiently accomplished via the income tax. Whether one redistributes income by tax or legal rule, the distortion to labor/leisure choice is the same: in particular, when legal rules turn on income, agents will take this into account as much as a tax table in choosing how much to work. But redistributing via legal rules has the added disadvantage that it also distorts the behavior that the legal rule is meant to regulate—for example, the choice of care in tort.

The present paper does not take issue with this argument *per se*, but rather with the conclusion that KS and many in the field may have drawn from it: namely that

> it is appropriate for economic analysis of legal rules to focus on efficiency and ignore the distribution of income. [KS (1994), *last line of conclusion,* p. 677]

or put another way

> the normative economic analysis of legal rules should be primarily concerned with efficiency rather than the distribution of income. [KS (1994), p. 675]

In a sense, the point of this paper is to show that "ignoring the distribution of income" is not the same as "focusing on efficiency"; that being "primarily concerned with efficiency" is not the opposite of being primarily concerned with the distribution of income.[1]

In particular, we use KS's own model to make three points about the use of legal rules as instruments for equity.

First, we show that even in the presence of an optimal income tax—any concern for equity dictates that legal rules deviate from efficient standards in a manner that aids the less well-off—this, so long as there is any heterogeneity in the way that agents respond to the legal system. If the well-off tend to be relatively cautious, damages should be set below harm caused. If the well-off tend to be relatively careless, damages should be set above harm caused. Either way the tort system should effect a transfer from the more well-off to less well-off.

Second, we show that if labor income is the primary source of differences in well-being—if the less well-off are indeed the "poor"—then damages should be specifically adjusted to help low income individuals.

Third, we show that it may even by optimal to adjust legal rules specifically to correct income-based inequality. In the KS model this arises when the income differences predominate and high income individuals tend to be accident prone. In this

[1] The broader assertion that legal rules should be set solely on the basis of efficiency appears elsewhere in KS. Consider the list of quotes from articles in the second paragraph of KS's footnote 3. Recited as examples of incorrect thinking, these concern the issue of whether legal rules should be set efficiently, not the narrower issue of whether legal rules should be conditioned on income (which is not to say that these sources are immune to KS's critique on the narrower issue).

Consider as well, the "qualifications" that KS provide in a remark at the end of their technical appendix. These assumptions are unnecessary to the argument against conditioning on income. They do, on the other hand, constitute an "argument" for setting rules purely on the basis of efficiency: but only in terms of bare logic. In contrast to the relatively airtight argument against conditioning on income, the argument from these assumptions is crippled by the assumptions' lack of empirical grounding or even introspective plausibility. We discuss this more in our remarks.

case, legal rules, though not made contingent on income *per se*, will in fact be used to mitigate the source of income inequality.

How precisely do these findings fit with KS's admonition that damages not be conditioned on income? A careful explanation goes to the foundations of second best analysis. Recall from the Second Welfare Theorem that if we could somehow directly tax individuals' immutable characteristics (preferences and endowments), we could happily achieve any distribution of well-being that we please with no loss of efficiency. Unfortunately, all we have to work with are the observable manifestations of the choices that individuals make based on these unobservable underlying characteristics. Thus based on preferences and endowments, individuals choose how much to work, how much to consume, how much care to take, whether to become a landlord. We in turn observe their income, their consumption, the accidents they cause, their ownership of renter occupied housing.

From a tax perspective, these observables are essentially imperfect "signals" of the underlying characteristics that we would really like to get at. They are imperfect because they are choice-determined and so taxing (subsidizing) them induces tax-reducing (subsidy increasing) shifts in behavior. If we tax labor income, people work less. If we "tax" accidents (by raising damages above harm) people are more cautious. If we tax lessor status, fewer people rent out apartments. Absent some countervailing externality, this "distortion" of behavior will involve efficiency losses.

Yet, if we care about equity, we may be willing to tolerate some efficiency loss for the sake of greater equality. In particular, each of these signals will typically have some equity content, which is to say that each will be in some direction correlated with individuals' over all well-being. Either taxing or subsidizing the signal will then have equalizing effects.

KS's argument that we not condition damages on income generalizes to the admonition that we not "tangle" the signals in setting these equity-based taxes.[2] Thus, signal B should not be used as a factor in determining how much tax we impose on signal A. If B is what we are after, we are better off taxing it directly. Getting at B through A distorts both the behavior generating A and the behavior generating B. KS highlight the particular point that we should not condition damages on income. Likewise, we should not condition tax rates on harm caused. Nor should we impose higher income taxes or damages on landlords, etc.

Yet the admonition not to tangle the signals says nothing about which signals should be used. Specifically, the argument against conditioning damages on income is not an argument for leaving legal rules out of our program of equity-based taxation—i.e., not an argument for setting legal rules solely on the basis of efficiency. Quite the contrary, legal rules will always have some role to play,[3] as per our first finding. The reason is the familiar one that "mountains are flat at the top." Efficient rules maximize total surplus and by the usual first order condition, this is precisely where the marginal impact on total surplus of adjusting the rule is zero. Thus, there is initially no

[2] This point may be seen as an incarnation of the doctrine that policies aimed at a specific variable should attack that variable as directly as possible. Thus in a seminal paper on trade policy, Bhagwati and Ramaswami[2] (1963) advocate subsidizing domestic industry directly rather than aiding domestic industry via import tariffs: both distort the decisions of domestic producers; taxing imports imposes an additional distortion on consumer choice.

countervailing efficiency loss to adjusting damages off of efficient standards for purposes of equity. Consequently, some adjustment will always be warranted.

Before turning to the body of the paper, it should be noted that our argument here is made solely within the context of the sort of second best/optimal tax framework analyzed in KS[4]. Not considered are the many other dimensions which may determine the relative efficacy of taxes and legal rules as redistributional tools. The paper does not, for example, discuss empirical issues, nor the political economy of judges versus legislators; nor the fact that the application of legal rules is inherently probabilistic. (As in KS, agents are risk neutral in this paper and so this is of no consequence.) Like Calabresi (1991), we note only that it is "far from obvious that, as a general matter, tax and welfare programs are more efficient than a mixture of these and of other rules of law."[5]

Yet, the present paper stays within the KS framework only because its purpose is to challenge the <u>internal</u> consistency of conclusions drawn inside its boundaries, not because factors external to the model are considered unimportant. On the contrary, there is good reason to believe that arguments of the sort left out of KS will in the end be decisive. Indeed, this paper may be seen as an attempt to unclog the overall debate of any notion that it has already been neatly settled, so that the discussion may flow freely toward these other more relevant issues.

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[3] More precisely, this holds in a model such as that in KS where key functions are assumed to be continuously differentiable. Otherwise, total surplus could in principal be maximized at a non-differentiable point.

The paper consists of four sections. The first presents a modified version of the KS model. The second makes the three main points of the paper as already discussed. The last section provides a detailed numerical example. A technical appendix conducts some of the algebra used in the main text and solves the full optimal tax/damages problem for general welfare functions.

2. The Kaplow and Shavell Model When Heterogeneity is not Restriced to Labor Markets

To assure the reader that our point is not an esoteric modeling quirk, we will work from KS's own model. Our chief alteration will be to drop the assumption that agents are precisely identical in relation to the tort system. This is discussed in more detail when the tort system is introduced formally below.

The population consists of a continuum of individuals. Each chooses how much *labor* $H \geq \ell \geq 0$ to supply,[6] and how much *care* $x \geq 0$ to take.

[4] KS shore up their argument against redistributional legal rules with a brief and casual discussion of several "additional considerations" that do not appear in their model.

[5] As quoted in KS, fn. 3.

[6] We add a maximum amount of labor supply H to the KS model, since without it the model has no solution. Note that KS need not, and do not actually solve their model to make their argument against conditioning damages on income.

2.1 Labor Market

If an individual chooses to work ℓ hours, she earns $y = \alpha\ell$ in *pre-tax income*, where $\alpha > 0$. Individuals differ according to their *(productive) ability* α. We discuss the precise distribution of α below. Ability α is the private information of the individual. The social planner knows the distribution of α in the entire population, but is unable to attach specific α's to specific individuals.

The individual keeps $y - t(y)$ of her pre-tax income, where the function t, the *tax schedule*, is a policy variable. The value $t(y)$ may be negative for some levels of y signifying that an individual with this level of income receives a net transfer from the government.

2.2 Tort System in KS

In KS if an individual takes care level x then the probability that she causes an accident will be $p(x)$, where p is assumed to be strictly decreasing and strictly convex: $p' < 0$, $p'' > 0$. Whenever an accident occurs it causes the same amount of harm h. Thus the *efficient level of damages*, the level minimizing the cost of accidents, is $d = h$. Harm is born equally by all individuals in the population. The individual causing the harm must pay damages of d. Like the tax system t, d is a policy variable.

2.3 Individual Choice in KS

In KS an individual with ability α chooses labor ℓ and care x to maximize *expected utility*:

$$EU\Big(\underbrace{\ell, x}_{\text{choices}}; t, d, \alpha\Big) = \underbrace{\Big[\underbrace{\alpha\ell - t(\alpha\ell)}_{\text{after tax earnings}} - \ell\Big]}_{\text{from Labor Choice}} - \underbrace{\big[x + p(x)d\big]}_{\text{from Care Choice}} - \underbrace{\bar{p}(h-d)}_{\substack{\text{unrecovered harm}\\ \text{caused by others}}}, \qquad \text{(KS1)}$$

where $\bar{p}$ is the *average accident probability* across the population (defined in more detail below) and so $\bar{p}(h-d)$ is the expected amount of unrecovered harm (possibly negative) befalling this individual.[7]

2.4 Adding Heterogeneity to KS's Tort System

Scrutiny of (KS1) reveals that the individuals in KS's population are homogeneous with respect to the tort system in a very strong sense. Whatever the level of damages *d*, all agents choose the same level of care, the level $x^*(d)$ minimizing $x + p(x)d$. More than this, the legal system's contribution to their total utility will also always be the same, namely $v^T(d) = -\big[x^*(d) + p(x^*(d))d\big] - \bar{p}(h-d)$.

It will come as no surprise then, that the legal system is useless as a redistributional tool in the KS model as it stands: trying to redistribute with the legal system in their model is like trying to play the piano with a two-by-four. To be sure, the validity of KS's admonition against conditioning damages on income is unaffected by this simplifying assumption and so it was the right assumption to make in that context. But in investigating the relative efficacy of taxes versus legal rules as redistributional tools, it is important that one's simplifying assumptions not dictate the answer.

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[7] Note that equation (KS1) is quite a bit simpler than the corresponding equation in KS because, wizened by their finding, we do not consider making damages contingent on the income of the parties. Note also that like KS, care choice is not subject to a budget constraint. This simplifies the analysis but does not change the results.

Thus we will alter the KS model by adding the realism-enhancing feature that individuals' differ with respect to their interaction with the tort system. *There are many ways to do this and we have chosen but one*—for its simplicity and its ready analogy to the manner in which KS model differences in labor choice. Thus we keep the assumption that harms are born equally by all, but stipulate that care choice x results in an accident probability of $p(\gamma x)$, where *care effectiveness* $\gamma > 0$ differs across individuals.

The *efficient level* of damages is still $d = h$, despite the new heterogeneity in care choice. This is still the level of damages that causes all individuals to equalize the marginal social costs of care, 1 with its marginal social benefit, $\gamma p' h$ (now heterogeneous across individuals).

2.5 Individual Choice in the Modified Model

Individuals are now distinguished along <u>two</u> dimensions, productive ability α and care effectiveness γ and individual (α,γ) chooses labor ℓ and care x to maximize expected utility given taxes t and damages d:

$$EU\Big(\underbrace{\ell,x}_{\text{choices}};t,d,\alpha,\gamma\Big) = \underbrace{\Big[\underbrace{\alpha\ell - t(\alpha\ell)}_{\text{after tax earnings}} - \ell\Big]}_{\text{from Labor Choice}} - \underbrace{\big[x + p(\gamma x)d\big]}_{\text{from Care Choice}} - \underbrace{\bar{p}(h-d)}_{\substack{\text{unrecovered harm}\\ \text{caused by others}}} \tag{2}$$

We introduce some additional notation to describe the solution to the individual's choice problem. Let $\ell^*(t,\alpha)$ and $x^*(d,\gamma)$ be the expected utility-maximizing choice of leisure and care[8] by an individual of productive ability α and care effectiveness γ when faced with tax system t and damages rule d. Our notation reflects the fact that the choice of labor and care are separable under KS's utility function. Let

$$v(t,d,\alpha,\gamma) \equiv EU\left(\ell^*(t,\alpha), x^*(d,\gamma); t,d,\alpha,\gamma\right) \tag{3}$$

be the individuals' *indirect utility function*, the maximum level of expected utility attainable for individual (α,γ) when taxes are t and damages are d. We can divide indirect utility into two parts: the utility derived from optimal labor choice,

$$v^L(t,d,\alpha) = \alpha\ell^*(t,\alpha) - t\left(\alpha\ell^*(t,\alpha)\right) - \ell^*(t,\alpha), \tag{4}$$

and the utility derived from the tort system:

$$v^T(d,\gamma) = -x^*(d,\gamma) - p\left(\gamma x^*(d,\gamma)\right) - \bar{p}(h-d). \tag{5}$$

2.6 The Population Distribution

We represent the population distribution of ability α and care effectiveness γ with the joint density function $f(\alpha,\gamma)$ over pairs of non-negative numbers.[9] The density need not have full support. From this joint distribution f, we can recover the population density of each parameter individually. Thus we write

$f(\alpha) = \int_0^\infty f(\alpha,\gamma)\, d\gamma$ and $f(\gamma) = \int_0^\infty f(\alpha,\gamma)\, d\alpha$ for the marginal density of ability α and care effectiveness γ, respectively. Note then that the probability of injury faced by

[8] Two technical notes: 1) Because of the separability of expected utility, optimal leisure depends only on α and optimal care, only on γ; 2) For ease of exposition, we will proceed as if the tax schedule and damages considered are such that first order conditions provide a unique solution. Nothing is lost if this assumption is relaxed. See Fudenberg and Tirole (1990).

[9] Here also we have generalized KS, in which α is assumed to be distributed uniformly between 0 and 1.

any individual in the population—in this model, the population average probability of harm—is $\bar{p} = \int_0^\infty \int_0^\infty p(\gamma x^*(d,\gamma)) f(\alpha,\gamma)\, d\alpha\, d\gamma = \int_0^\infty p(\gamma x^*(d,\gamma)) f(\gamma)\, d\gamma$.

2.7 Representing the Equity/Efficiency Trade-off with a Social Welfare Function

We are interested in determining what the optimal tax system and damages rule would be if we were concerned not just about the "total" well-being in our economy, but also about how that total is distributed among our population. To consider these issues with precision and consistency, we imagine the problem faced by a fictional "social planner" who chooses the tax system t and the damages rule d to maximize a well-defined "social welfare function." The social welfare function will express the planner's preferences over policy variables and will incorporate in a coherent manner the planner's attitude toward what is casually thought of as the equity/efficiency trade-off. Positing a social welfare function is the usual manner such issues are considered in the optimal tax literature.

We suppose that the planner chooses t and d to maximize the following weighted sum of individual utilities:

$$SWF(t,d) = \int_0^\infty \int_0^\infty W(v(t,d,\alpha,\gamma))\, d\alpha\, d\gamma \;, \tag{6}$$

where W is the *weighting function.* In the main text of the paper, we analyze the case in which W is the increasing side of an upside-down parabola:[10]

$$W(v) = bv - \tfrac{1}{2}av^2 \;, \tag{7}$$

[10] Appendix B considers more general social welfare functions.

where a and b are nonnegative constants. Thus, W increases at a decreasing rate until reaching a maximum at $\frac{b}{a}$. We assume that b is large enough so that W is always increasing in v over the relevant range.

Several things are worth noting about this social welfare function. First, the fact that W increases in v means that the planner's preferences over policy variables respect Pareto superiority. In other words, if all individuals are better off at taxes t and damages d than at taxes t' and damages d', the planner prefers t, d to t', d'. Of course, this does not mean that the planner's solution will be Pareto optimal if that term is defined relative to what is feasible in a first best world, i.e., relative to what is feasible when the planner can observe each agents' α and γ.

Secondly, the planner is concerned about equity to the extent that W's slope, $W'(v)$, is <u>de</u>creasing in v—i.e. the extent to which W is concave. When (and only when) this is the case, the planner would, if given the opportunity, choose to make a one-for-one transfer from a well-off individual $\bar{v}$ to a less well-off individual $\underline{v}$. Since W flattens as it increases, the increase in social welfare from "transferring utils" <u>to</u> the less well-off will exceed the decrease in social welfare from transferring <u>from</u> the more well-off. Of course, in the second best world we consider, such transfers can only be effected by altering taxes and damages. Thus one-for-one transfers will not in general be possible—resources will be lost in transit due to the distortionary effects of the only tools at our disposal. Nevertheless, an equity concerned social planner will tolerate some "leakage in the bucket"—even if less arrives at the less well-off, the fact that each util that survives the transfer has a net positive impact on social welfare, may outweigh the fact that other utils are lost along the way. The extent of the social planner's tolerance for such leaks is reflected in the speed at which W flattens, for this determines the net gain from the utils that survive the transfer. Thus, the speed at which W flattens is a precise representation of the weight that the planner places on equity in the equity/efficiency trade-off.

Given the quadratic form (7), $W'(v) = b - av$. Thus the planner is concerned about equity if and only if the parameter a is strictly positive. If a is zero, then $W(v) = bv$, and so the planner maximizes (b times) the sum of individual utilities, with no concern for how the sum is distributed. The *efficient* tax system t and damages rule d are those that optimize social welfare in this case. The reader can check that setting damages equal to harm and imposing no tax system is efficient.

The last thing to note about the planner's problem is that we have written social welfare as a function of <u>optimized</u> utility, $v(t,d,\alpha,\gamma)$. This reflects the fact that the planner takes into account how individuals react to her choice of policy instruments, t and d.

3. Analysis of the Modified KS Model

In this section we give formal content to the three main points of the paper: 1) even in the presence of an optimal income tax, <u>any</u> concern for equity dictates that legal rules deviate from efficient standards in a manner that aids the less well-off—this, so long as there is <u>any</u> heterogeneity in the way that agents respond to the legal system; 2) when, in addition, income differences are predominant in over-all inequality, legal rules should in fact be adjusted away from efficient standards in a manner that helps low-income individuals; 3) under certain additional conditions, legal rules should be specifically adjusted to correct income-based inequality.

3.1 Optimally Inefficient Damages

Should we set damages at their efficient level? If not, in what direction should they be adjusted? To answer these questions we need only examine the derivative of social welfare with respect to d and evaluate that derivative at efficient damages $d = h$ and optimal taxes (given $d = h$). If this derivative differs from zero, then the answer to our first question is no: efficient damages are not optimal. We can then examine the sign of this derivative and more importantly, what determines that sign, to answer the second question.

Some simple algebra (performed in an Appendix A) reduces the damages derivative of social welfare to:

$$SWF_d(t,d) \;=\; \underbrace{-(b-a\bar{v})\bar{p}_d(h-d)}_{\text{Efficiency Effect}} \;+\; \underbrace{a\,\mathrm{cov}[v,p]}_{\text{Equity Effect}}, \tag{8}$$

where $\bar{v} = \iint v(t,d,\alpha,\gamma)f(\alpha,\gamma)$ is average well-being and $\bar{p}_d$ is the derivative of the average accident probability with respect to d.

Consider first the term labeled "Efficiency Effect." When the social planner has no concern for equity ($a = 0$), but rather acts simply to maximize (b times) the simple sum of individual well-being, the derivative of social welfare with respect to damages consists solely of this term:

$$a = 0 \Rightarrow \qquad SWF_d(t,d) = -b\bar{p}_d(h-d).$$

Setting $d = h$—setting damages "efficiently"—zeroes out this term and so (given second order conditions) maximizes aggregate well-being.

The flip side of this observation, however, is that when the planner is concerned with equity $(a > 0)$, and we evaluate the derivative SWF_d at efficient damages $d = h$, *there is no Efficiency Effect* and the only term left is what we have labeled the Equity Effect:

$$SWF_d\Big(t,\underset{\Uparrow}{h}\Big) = \underbrace{a\operatorname{cov}[v,p]}_{\text{Equity Effect}}.$$

This equity term says that the social welfare derivative with respect to d is proportional to the covariance of well-being v and accident proneness p, with the constant of proportionality a being a measure of equity concern.

To understand what lies behind this covariance term and why it is an "Equity Effect," suppose for the moment that the well-off tend to be accident prone, i.e. $\operatorname{cov}[v,p] > 0$. Then $SWF_d(t,d) > 0$ and the planner will want to raise damages above harm. Why? When well-being and accident proneness vary together, the less well-off will cause fewer than average accidents. Since the average probability of accidents $\bar{p}$ is each individual's probability of injury, this means that the less well-off tend to receive damages more often than they pay them. The converse is true for the more well-off. Thus, in this case raising damages effects a transfer from well-off to less well-off.

If, on the other hand, the less well-off tend to be accident prone $\text{cov}[v,p]<0$, then the planner will want to lower damages below harm. Since the less well-off now pay damages more often than they receive them and vice versa for the well-off, this is now the adjustment that effects a transfer from well-off to less well-off.

Now any planner concerned with equity—any planner putting more weight on the less-well off—is predisposed to make such a transfer. This, so long as the efficiency loss—the leak in the bucket—is not too great. The point is that starting from $d=h$, the leak will never be too great to preclude at least some movement off of efficiency. That the Efficiency Effect drops out at $d=h$ reflects the fact that the marginal efficiency loss from moving off efficient damages will be zero.

Will it ever happen that setting damages efficiently is socially optimal? This is the same as asking whether $SWF_d(t,h)=a\,\text{cov}[v,p]$ will ever be zero. As already noted, if our concept of social welfare contains no concern for equity—that is, $a=0$—then $a\,\text{cov}[v,p]$ vanishes and setting damages equal to harm $d=h$ is in fact optimal. Moreover, if there is no heterogeneity in tort, so that p is constant across the population—as in the original KS model—then $a\,\text{cov}[v,p]$ vanishes again (the covariance of any random variable and a constant is zero) and efficient damages are best. Lastly, if there is no variation in well-being across agents, so that v is constant across agents, then $a\,\text{cov}[v,p]$ again vanishes.

This last case can be immediately ruled out: in particular, no tax system[11]—let alone the optimal one—will eliminate all differences in well-being. The most obvious residual differences will be those due to tort utility. But it is crucial to note that even within the realm of labor utility, an income tax can never fully eliminate utility differences due to productivity differences.

To see this, note first that the productive individual need not work as hard to earn the after-tax income, call it $\underline{e}$, implied by the unproductive individual's optimal choice of labor. Thus were both individuals to choose to work however many hours would yield them each $\underline{e}$, the productive individual would have higher labor utility as between the two. And if the productive does better than the best the unproductive can do when she chooses labor to earn $\underline{e}$, then certainly she does better when she chooses labor to maximize her utility.

Having ruled out the possibility that v is constant across the population, we conclude that so long as there is any concern for equity ($a > 0$) and any heterogeneity in tort (p varies), efficient damages will be optimal only in the case that v and p vary in a way that is perfectly orthogonal ($\text{cov}[v, p] = 0$). Where, as here, perfect orthogonality is not imposed by the structure of the model, it is a knife-edge phenomenon that can be safely neglected. We conclude:

OBSERVATION 1: So long as there is any heterogeneity at all in the tort system and any concern for equity, efficient damages will not be socially optimal. In

[11] More precisely, no tax system under which at least some individuals choose to work at least some amount.

particular, when the well-off tend to be relatively (less) accident prone, social welfare can be increased by raising (lowering) damages above (below) their efficient level.

3.2 Helping the Poor

The reader will notice that we have been careful in the previous section to use the somewhat awkward phrasing "less well-off" and "more well-off" rather than "poor" and "rich," or "high income" and "low income." Any serious discussion of equity must be centered on some notion of overall well-being that accounts for the utility effects of hours worked and the utility contribution of the tort system—income, even wealth and consumption, are merely proxies for the real target.

This does not, however, preclude the possibility that one or several of these together form a good proxy for overall well-being—that, for example, the "poor" are in fact less well-off. Adjusting damages to help the less well-off will then be essentially the same as adjusting damages to help the poor.

How can this be reconciled with KS? It is crucial to note that we will not be conditioning damages in each case on the income of the parties. Rather we will be shifting damages in the same direction for all parties in a way that we have calculated will tend to help the poor. In particular—and this is the operative distinction—an individual will not affect her own expected damages by earning more or less income. Thus, KS's double distortion argument will not apply. The general point here is that the double distortion argument against equity-inspired adjustments to legal rules is a narrow obstacle; side-stepping it still leaves a lot of room to maneuver.

Formally, we will show that when after-tax income is the predominant cause of inequality in well-being, then we should adjust damages to help the "poor." We accomplish this via a simple rearrangement of (8). As noted, total welfare $v = v^L + v^T$ is the sum of labor welfare and tort welfare. Further, $v^L = e - \ell$, where $e = \alpha\ell - t(\alpha\ell)$ is after-tax income. Then using a familiar rule for the covariance[12] we may write,

$$\begin{aligned} SWF_d(t,h) &= a\,\mathrm{cov}[v,p] \\ &= a\,\mathrm{cov}\left[v^L + v^T, p\right] \\ &= a\,\mathrm{cov}\left[v^L, p\right] + a\,\mathrm{cov}\left[v^T, p\right] \\ &= a\,\mathrm{cov}[e,p] - a\,\mathrm{cov}[\ell,p] + a\,\mathrm{cov}\left[v^T,p\right] \end{aligned} \tag{9}$$

Working with the correlation coefficient $1 \geq \mathrm{corr}[X,Y] = \frac{\mathrm{cov}(X,Y)}{\sigma_X \sigma_Y} \geq -1$ rather than the covariance will allow us to talk about the degree to which two variables vary together, independent of their scale. Thus, multiplying and dividing through by various standard deviations yields finally,

$$SWF_d(t,h) \;\propto\; \tfrac{\sigma_e}{\sigma_v}\mathrm{corr}[e,p] - \tfrac{\sigma_\ell}{\sigma_v}\mathrm{corr}[\ell,p] + \tfrac{\sigma_{v^T}}{\sigma_v}\mathrm{corr}\left[v^T,p\right] \tag{10}$$

This expression tells us that the change in social welfare $SWF_d(t,h)$ from increasing damages d above harm h is proportional to ("$\propto$") a weighted sum[13] of the correlation between accident proneness p on the one hand and after-tax income e, labor supply ℓ

[12] Namely, $\mathrm{cov}(X+Y,Z) = \mathrm{cov}(X,Z) + \mathrm{cov}(Y,Z)$.

[13] The weights will not necessarily add to one.

and tort well-being v^T on the other. The weights reflect the importance of each welfare source in the distribution of overall well-being v.

We see then that if differences in after-tax income are important determinant of overall inequality—that is, if $\frac{\sigma_e}{\sigma_v}$ is relatively large compared to $\frac{\sigma_\ell}{\sigma_v}$ and $\frac{\sigma_{v^T}}{\sigma_v}$—then the sign and size of the welfare change from increasing damages d will follow the sign and size of the correlation $\text{corr}[e, p]$ between after tax income and accident proneness. Thus,

> *Observation 2: If the labor market is the predominant source of inequality in overall well-being, then social welfare increases when damages are adjusted away from their efficient level in a manner that helps low-income individuals.*

3.3 "Cross Over"

We have seen that the equity conscious social planner will always make equity based adjustments in damages, and that quite plausibly these will be made specifically to help low income individuals. In this section we go one step further and show that these adjustments may actually be disequalizing within the realm of tort. This is significant because it is sufficient (though not necessary) to conclude that the damages adjustments are being made specifically to mitigate labor market inequality. We call this general phenomenon *cross over.*

To see how this would come about, suppose momentarily that the planner cares only about tort well-being. As should be clear from the previous analysis, the derivative of social welfare with respect to d evaluated at $d = h$ would then reduce to

$$a\,\mathrm{cov}\left[v^T, p\right].$$

The analysis of this term essentially tracks the above analysis of $a\,\mathrm{cov}[v, p]$, except that here there is only one possibility: the covariance $a\,\mathrm{cov}\left[v^T, p\right]$ is always negative since the accident prone are always tort worse off.[14] Thus an equity conscious social planner, who for some reason cares only about tort well-being will choose to lower damages below their efficient level in order to help the less well-off in tort. The opposite adjustment would be disequalizing within the realm of tort.

But when the equity conscious planner cares about total well-being, the opposite adjustment is quite plausible. In particular, we know from the second to last line in (21) that when labor inequality is predominant in overall inequality, then the sign of $SWF_d(t,h)$ will follow $\mathrm{cov}\left[v^L, p\right]$. This will in turn be positive when those who are well-off in labor markets tend to be accident prone, as when α and γ are negatively correlated. Thus:

OBSERVATION 3: When labor markets are the predominant source of overall inequality and the rich tend to be relatively accident prone, then the equity

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[14] On the one hand, the care effective are always better off in tort for the same reason (explained above) that the productive are better off in the labor market: the care effective individual can produce the care ineffective individual's optimal accident probability with less care effort. On the other hand, the care effective individual always has a greater care effect γx since her effort cost for each unit of care effect is lower. Therefore tort well-being v^T and accident proneness p move in opposite directions as we vary care effectiveness γ. This in turn implies a negative covariance.

Formally, defining $c = \gamma x$, the agent chooses c to minimize $\frac{c}{\gamma} + p(c)d$. Then $v^T_\gamma = c\gamma^{-2} > 0$. Also, applying the implicit function theorem to the first order condition, $\frac{-1}{\gamma} - p_c(c)d = 0$ yields $c_\gamma = \frac{1}{\gamma^2 p_{cc} d} > 0$. So $p_\gamma = p_c c_\gamma < 0$. Thus p moves against v^T as γ varies.

conscious social planner will wish to raise damages above their efficient level and this will be done specifically to mitigate labor market inequality.

4. Illustrative Numerical Example

The last section concerns local adjustments off of efficient damages, but does not characterize the global optimum. This is in line with most of the optimal tax literature and is generated by the difficulty of deriving analytical solutions in this sort of problem. In this section we report the optimal tax and damages rule in an extended numerical example to show how all three of the points made in the last section extend to the global solution.[15]

The example was calculated using an Excel spreadsheet. Instead of a continuum of different α's and γ's as in KS, we set up a square grid of possible values. The grid was 11×11 and ran in each dimension—α and γ—from .1 to 10.1. We then posited a population distribution on this grid. As shown in Figure 1, this distribution was specifically chosen so that productive ability and care effectiveness would be negatively correlated. The lightest region represents (α, γ) pairs populated by three agents, the darkest, two agents, and the remaining region, one agent.

[15] The example is not intended to be a calculation of optimal policies for the real economy.

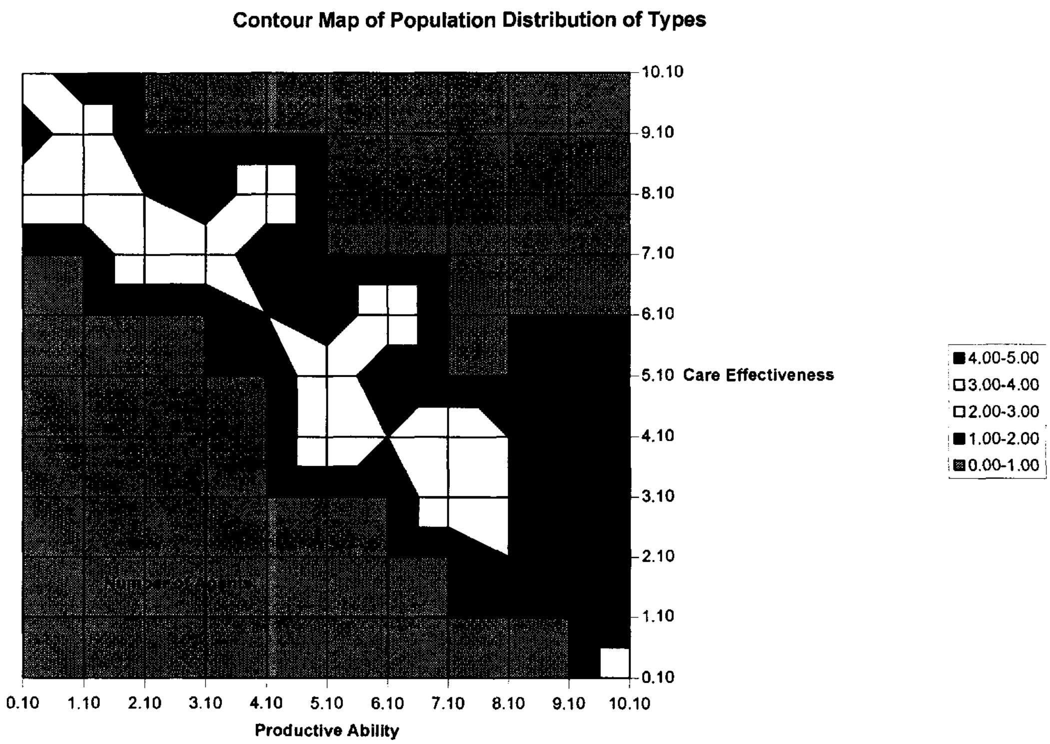

Figure 1 : The Joint Distribution of Ability and Care Effectiveness

The other parameters and functional forms we used in the example are given in Table 1.

LABOR MARKET	
Maximum Labor Supply, H	10,000
TORT SYSTEM	
Accident Probability Function, $p(\gamma x)$	$p(\gamma x) = \frac{1}{1000}\frac{1}{\gamma x}$
Harm of each Accident, h	1,000,000
WELFARE FUNCTION, $W(v) = bv - av^2$	
b	100,000
a	1

Table 1: Parameters for Numerical Example

4.1 Efficient Solution

With <u>any</u> parameters, as with these, the full efficient solution—the solution that maximizes the straight sum of individual utilities, or equivalently, social welfare with $a = 0$—is to set damages equal to harm and construct a tax system that induces every agent with productivity α exceeding 1 (the marginal disutility of labor) to work the maximum number of hours H. One (but not the only) tax system that accomplishes this is $t(y) = 0$ for all y.

4.2 Efficient Damages with Optimal Taxation

The *efficient damages solution* is the social optimum given the welfare function specified in the table, but <u>under the constraint that damages are set efficiently</u>.

4.2.1 Optimal Taxes with Efficient Damages

The optimal tax under this restriction turns out to be one that induces all agents with ability α over the higher threshold of 2.1 to work all the time H and agents with ability below 2.1 to work not at all. (Indeed as shown in Appendix B, this bang-bang pattern of labor supply is a general property of the KS model).

To find a tax schedule inducing individuals to work in this pattern, consider for any constant C the following schedule as graphed in Figure 2

$$t(y)=\begin{cases}\left(1-\frac{1}{\alpha^c}\right)y-C, & y<\alpha^c H\\ y-H\ln y-\left(H-H\ln\alpha^c H\right)-C, & y\geq\alpha^c H\end{cases}. \tag{11}$$

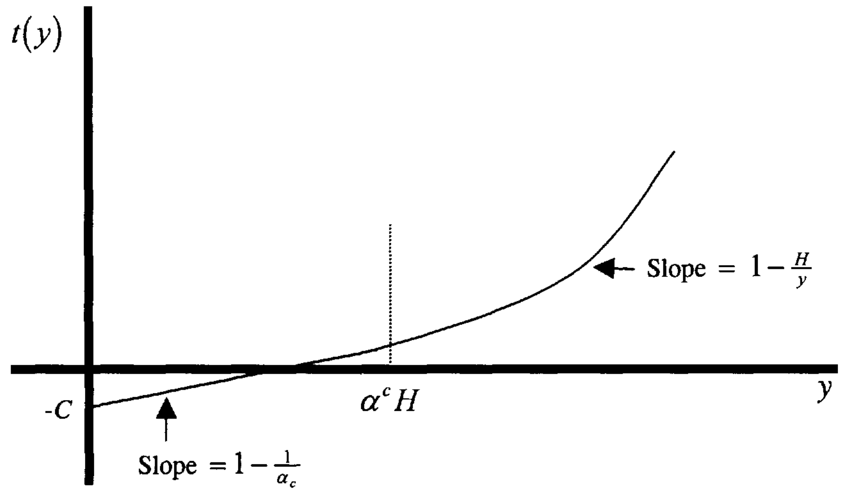

Figure 2: The Optimal Income Tax Schedule (Modulo C)

The implied increasing marginal tax rate is then

$$t_y(y)=\begin{cases}1-\frac{1}{\alpha^c}, & y<\alpha^c H\\ 1-\frac{H}{y}, & y\geq\alpha^c H\end{cases}$$

Thus the marginal increase in after tax income from earning another dollar of pre-tax income is:

$$1-t_y(y)=\begin{cases}\frac{1}{\alpha^c}, & y<\alpha^c H\\ \frac{H}{y}, & y\geq\alpha^c H\end{cases},$$

Thus the net utility gain for individual α from earning another dollar of pretax income is:

$$1-t_y(y)-\frac{1}{\alpha}=\begin{cases}\frac{1}{\alpha^c}-\frac{1}{\alpha}, & y<\alpha^c H\\ \frac{H}{y}-\frac{1}{\alpha}, & y\geq\alpha^c H\end{cases}.$$

This is always (over all y) positive for individuals with $\alpha > \alpha^c$ and never larger than $\frac{1}{\alpha^c} - \frac{1}{\alpha}$, and so always negative, for individuals with $\alpha < \alpha^c$. Thus this schedule induces the choice of labor desired by the planner. The constant C can then be adjusted to insure fiscal balance.

Thus the planner essentially employs a tax cum uniform transfer scheme. The "tax" portion (i.e., neglecting C) is progressive in the sense that both the marginal and average tax rates increase in pre-tax income. The net effect of the tax is to collect resources from those with ability exceeding some critical level. The tax rate harms work incentives in the KS model only in the very stark sense here that fewer agents work at all as compared to a no tax regime; those who continue to work continue to work the same amount, which is always. The revenues from the tax are then transferred equally to all individuals.

4.2.2 Derivative of Social Welfare with Respect to Damages

As in the previous section we can examine the derivative of social welfare with respect to damages at this efficient damages solution in order to determine whether and how damages should be adjusted relative to harm. We will then compare this to the global solution. We know that this derivative can be written in two ways both of which concern various statistics of dispersion and correlation. These are collected in the following table:

	Standard Deviation	Standard Deviation/ Standard of Deviation of Well-being	Correlation with Accident Proneness, p
Total Well-being, v	5622	1.00	**0.25**
Labor Well-being, v^L	5633	1.00	0.26
Tort Well-being, v^T	45	0.01	-1.00
After Tax Income	8563	1.52	0.25
Labor Supply	3809	0.68	0.38

We see immediately from the northeastern-most cell that total well-being is positively correlated with accident proneness. Since the welfare function exhibits some equity concern ($a = 1$), (and the covariance is proportional to the correlation) the covariance formula in (8) tells us that social welfare will increase if we increase damages above their efficient level.

With respect to the role of income in this derivative, we see from the middle column that after tax income is the major component of overall well-being and that it too is positively correlated with accident proneness. Specifically, equation (10) here calculates as

$$\begin{aligned} SWF_d(t,h) &\propto \tfrac{\sigma_e}{\sigma_v}\operatorname{corr}(e,p) - \tfrac{\sigma_\ell}{\sigma_v}\operatorname{corr}(\ell,p) + \tfrac{\sigma_{v^T}}{\sigma_v}\operatorname{corr}(v^T,p) \\ &= (1.52)\times 0.25 - (.68)\times 0.38 + (.01)\times(-1.00) \\ &= .38 - .26 - .01 \\ &= .12 - .01 \\ &= .11 \end{aligned} \tag{12}$$

Thus when we adjust damages upward to aid the less well-off, we are essentially adjusting damages upward to help the poor—income differences are what drive differences in well-being in this example.

4.3 Optimal Solution

In line with this local analysis, the spreadsheet reports that *the full optimal solution—in which taxes and damages are both allowed to vary—is to keep essentially the same tax system as in Section 4.2.1, but raise damages from 100% of harm to roughly 145%.* The same key statistics as above are given for this fully optimal solution:

	Standard Deviation	Standard Deviation/ Standard of Deviation of Well-being	Correlation with Accident Proneness, p
Total Well-being, v	5620	1.00	**0.25**
Labor Well-being, v^L	5634	1.00	0.26
Tort Well-being, v^T	**54**	0.01	-1.0
After Tax Income	8563	1.52	0.25
Labor Supply	3809	0.68	0.38

Two things are worth noting about this table in comparison with the table for the efficient damages solution: In the first place, the reader will see from its standard deviation that tort well-being has actually become <u>less</u> equal as a result of the increase in damages—with the realm of torts, our adjustment has been disequalizing. Our increase in damages hurts the care ineffective, who are already worse-off in tort. But the care ineffective tend to be productive and productivity is the chief determinant of inequality. The equity conscious social planner is using the damage adjustment to effect a transfer from well-off to less well-off. The transfer has costs—efficiency costs within the realm of tort. But until damages reach 145% of harm, these are outweighed by the welfare gains of the effective transfer.

As a final aside, it is worth noting that accident proneness and total well-being remain correlated when damages are set to 145% of harm. One might be tempted to conclude from that social welfare can be further increased by continuing to raise damages beyond 145%. Recall, however, the efficiency term in the social welfare derivative (8) reappears as damages rise above harm and militates with greater and greater intensity against further increases in d.

5. REMARKS

5.1 Damages as a Blunt Instrument

The tool we make available to our policy maker for regulating the tort system is far more primitive than the tool for regulating labor markets. With respect to torts, the policy maker works only with a single number, d, whereas in the labor market, the policy maker is free to choose any tax schedule, $t(y)$, including those that are progressive with a continuum of tax brackets. It is important to note that this lopsided specification cuts in favor of our argument. The fact that we will find an equity role for the tort system, even when the cards are so stacked against it, strengthens the case for using torts redistributionally when, as in the real world, more flexible tools are available.

5.2 Informational Requirements

One might object that the information necessary for the proper adjustment of damages is simply unavailable to the real world policy maker. Yet on a practical level, one must be willing to argue not just that the information necessary to alter damages precisely is missing, but that our limited knowledge means that our best guess at the proper adjustment is worse that no adjustment at all. In any event, use of the income tax for redistributional purposes has information problems of the same or greater magnitude, and so the information argument in general terms says nothing about the relative efficacy of the two methods.

5.3 Optimal Taxes, Hypothetical Income Tax-Only Results and KS's "Qualifications"

In the context of the economics literature on optimal taxation, [16] there is little novel about the argument we have provided. Legal rules like those considered in KS are in the first instance correctives for externalities in the manner of the classic Pigouvian tax. In a "first best world," where it is possible to tailor lump sum transfers based on agents' personal characteristics, the optimal corrective tax is indeed the Pigouvian, equating marginal and private social costs. But in a second best world, where personal characteristics are private information and personalized lump-sum transfers are thus precluded, the optimal corrective for externalities—even in the context of optimized taxes for all other commodities—deviates from what Pigou prescribed. The extent of the deviation is a matter of balancing distributional benefits with distortionary effects.

[16] See, e.g. Sandmo (1975) or the treatment of this paper in Atkinson and Stiglitz (1980), p. 451-454.

We have shown how that balancing would be accomplished in the simple tort externality model presented in KS.[17]

A sub-literature on optimal taxes considers conditions under which it would be optimal to tax <u>only</u> labor income. Without mentioning the literature on externalities just discussed, KS cite this sub-literature in support of their apparent claim that legal rules should be set efficiently. In the first place, contrary to their discussion, this literature is not in fact related to their valid and important argument against conditioning on income. With regard to the broader argument for setting rules efficiently, it is worth remarking that the conditions needed are both extremely restrictive theoretically and ungrounded empirically. A reading of this sub-literature's later stages[18] indicates that the spirit of these results was more as an answer to the hypothetical question "what would it take" for it to be optimal to tax only income. In this light, the conditions identified, given their restrictiveness, are more an argument <u>against</u> solely taxing income than for.

Essentially, the conditions require: 1) that individuals differ in their underlying characteristics <u>only</u> as these relate to labor/leisure choice, and even further 2) that the marginal rate of substitution between any two commodities not be affected by labor

[17] In a more general model, the tort externality is a more complicated issue because it is inherently probabilistic. This complication does not crop up in KS because their agents are risk neutral. Nor does the complication alter the main point in a more general setting.

[18] The literature culminates in Deaton (1981). Deaton (1981) presents these conditions not to argue that income taxes should be exclusively employed, but to show why existing empirical studies seeking to actually calculate optimal taxes were building a great deal of their results into their maintained hypotheses, since they were forced to adopt these conditions due to data limitations.

Those interested in this literature should note that there seems to be an error in the earlier Deaton (1976). All individuals' Engel curves need to be parallel; it is not sufficient that they are individually linear, since if they have different slopes then consumption on commodity n is not some uniform constant proportion of total expenditure. Compare the discussion in Deaton (1976) with the later discussion in Deaton (1981), which specifically mentions the requirement that Engel curves be parallel.

income, so that differences in underlying characteristics related to labor/leisure choice do not manifest in other non-labor choices. Taken together, the assumptions amount to the supposition that all economic activities save labor/leisure choice are useless as signals of individuals' underlying characteristics.

5.4 Other Sources of Heterogeneity viz. the Tort System

We introduce heterogeneity directly into the care decision in our model, but this is not the only way to do so. In line with the previous remark, it is worth noting that if we were willing to work with more general utility functions, we could derive similar results for populations of individuals that differ <u>only</u> in their productive ability. Heterogeneity in the tort system would then arise from the interaction between leisure choice and care choice. We declined to take this approach because it much more difficult mathematically and no more plausible.

5.5 Adding Legal Costs

The assumption that court cases use resources will not change the character of our results. As shown in Rubinfeld and Polinsky (1988), what will change, potentially, is the efficient level of damages. The proposition that we will always want to (further) alter damages for reasons of <u>equity</u> will continue to hold. Though the top of the mountain will have shifted, it will still be flat on top.

5.6 Decoupling

We remind the reader that we have imposed the restriction that damages paid equal damages received in every case. The fact that the optimal policy may deviate from this in an optimal tax setting is yet another reason for decoupling. For two other reasons see Polinsky and Che (1991) and Sanchirico (1997).

5.7 More Information from Court Cases

There is yet another possibly even more important reason to alter damages from their efficient level that we have not considered. This is the fact that court cases are likely to reveal much more information about the underlying characteristics of the individuals involved than just the harm that they have caused. To the extent that this information is yet another signal of individuals' underlying characteristics it will be optimal to condition upon it. We leave consideration of this very interesting issue to future research.

6. CONCLUSION

After all is said, Kaplow and Shavell (1994) are to be applauded for correcting the harmful misperception that it may be optimal to condition legal rules on the income (wealth, consumption, occupation, etc.) of the parties. Yet their apparent conclusion that there is therefore no loss to setting legal rules solely on the basis of efficiency goes too far. The argument that damages not be made contingent on income is simply not an argument for ignoring equity in setting legal rules. The close association in their paper of these two distinct assertions runs the risk that the compactness and solidity of the first will be attributed to the unproven and unprovable later. Our paper has attempted to guard against this risk by highlighting equity's role in the optimal choice of legal rules within their own framework. If nothing else, this exercise suggests that the ultimate determination of this important issue lies elsewhere.

7. APPENDIX A: THE DAMAGES DERIVATIVE OF SOCIAL WELFARE

Here we show how to derive equation (8). The derivative of $SWF(t,d)$ in d is:

$$SWF_d(t,d) = \iint W'(v(t,d,\alpha,\gamma))v_d(t,d,\alpha,\gamma)f(\alpha,\gamma)\,, \tag{13}$$

where v_d is the derivative of optimal individual utility.

Given $v(t,d,\alpha,\gamma) = \left[\alpha\ell^* - t(\alpha\ell^*) - \ell^*\right] - \left[x^* + p(\gamma x^*)d\right] - \bar{p}(h-d)$, we obtain $v_d = -p + \bar{p} - \bar{p}_d(h-d) - [1+\gamma p_x d]x_d^*$. Since the optimizing individual chooses x so that $1+\gamma p_x d = 0$,

$$v_d(t,d,\alpha,\gamma) = -\bar{p}_d(h-d) - (p-\bar{p})\,. \tag{14}$$

Substituting (14) into (13) and rearranging yields (8). Here are the explicit steps:

$$\begin{aligned}
SWF_d(t,d) &= -\iint W'(v)[\bar{p}_d(h-d) + (p-\bar{p})]f \\
&= -\iint W'(v)\bar{p}_d(h-d)f - \iint W'(v)(p-\bar{p})f \\
&= -\iint (b-av)\bar{p}_d(h-d)f - \iint (b-av)(p-\bar{p})f \\
&= -\bar{p}_d(h-d)\iint (b-av)f \underbrace{-b\iint (p-\bar{p})f}_{0} + a\iint v(p-\bar{p})f \\
&= -\bar{p}_d(h-d)(b-a\bar{v}) + a\iint (v-\bar{v})(p-\bar{p})f + \underbrace{a\iint \bar{v}(p-\bar{p})f}_{0} \\
&= -(b-a\bar{v})\bar{p}_d(h-d) + a\iint (v-\bar{v})(p-\bar{p})f \\
&= -(b-a\bar{v})\bar{p}_d(h-d) + a\operatorname{cov}[v,p].
\end{aligned}$$

8. APPENDIX B: GENERAL SOLUTION

Here we provide a more general solution to the optimal tax problem posed by the modified KS model. The techniques employed are familiar from the optimal tax and mechanism design literatures (See, e.g. Fudenberg and Tirole [1990]). The only potential complication is that our type space is two-dimensional, but since there is full separability across dimensions, the problem reduces to essentially two applications of the single dimensional technique.

We will reduce the planner's problem to one in which she chooses damages d and, subject to incentive constraints, how much $\ell(\alpha)$ each individual works. To this end, it is initially more convenient to proceed as if individual agents choose $y = \alpha\ell$ and $c = \gamma x$. By the envelope theorem,

$$v_\alpha(\alpha,\gamma) = \tfrac{y(\alpha)}{\alpha^2} \geq 0\,, \tag{15}$$

$$v_\gamma(\alpha,\gamma) = \tfrac{c(\gamma)}{\gamma^2} \geq 0\,, \tag{16}$$

where we have suppressed the notation for t and d.

These equations allow us to express the well-being of an arbitrary individual in terms of the well-being of the lowest type, which we will assume without loss of generality to be $(\underline{\alpha},\underline{\gamma})=(1,1)$.

More formally, we break the difference down into an α change and a γ change:

$$v(\alpha,\gamma)-v(1,1)=\left(v(\alpha,\gamma)-v(\alpha,1)\right)+\left(v(\alpha,1)-v(1,1)\right). \tag{17}$$

Then we apply the fundamental lemma of calculus to $v(\alpha,1)$ viewed as a function solely of α

$$v(\alpha,1)-v(1,1)=\int_1^{\alpha} v_{\alpha}(\tilde{\alpha},1)\,d\tilde{\alpha}=\int_1^{\alpha}\tfrac{y(\tilde{\alpha})}{\tilde{\alpha}^2}\,d\tilde{\alpha}$$

and $v(\alpha,\gamma)$ viewed as a function solely of γ

$$v(\alpha,\gamma)-v(\alpha,1)=\int_1^{\gamma} v_{\gamma}(\alpha,\tilde{\gamma})\,d\tilde{\gamma}=\int_1^{\gamma}\tfrac{c(\tilde{\gamma})}{\tilde{\gamma}^2}\,d\tilde{\gamma}\,.$$

(Note how the fixed variable in both expressions drops out.) Combining yields:

$$v(1,1)=v(\alpha,\gamma)-\int_1^{\alpha}\tfrac{y(\tilde{\alpha})}{\tilde{\alpha}^2}\,d\tilde{\alpha}-\int_1^{\gamma}\tfrac{c(\tilde{\gamma})}{\tilde{\gamma}^2}\,d\tilde{\gamma}\,. \tag{18}$$

Now we solve for $v(1,1)$. First, we substitute from the definition of $v(\alpha,\gamma)$:

$$v(1,1)=\left[y(\alpha)-t(y(\alpha))-\tfrac{y(\alpha)}{\alpha}\right]-\left[\tfrac{c(\gamma)}{\gamma}+p(c(\gamma))d\right]-\bar{p}(h-d)-\int_1^{\alpha}\tfrac{y(\tilde{\alpha})}{\tilde{\alpha}^2}\,d\tilde{\alpha}-\int_1^{\gamma}\tfrac{c(\tilde{\gamma})}{\tilde{\gamma}^2}\,d\tilde{\gamma}\,, \tag{19}$$

Next, we integrate (19) over the full range of (α ,γ). The left hand side is just $\iint v(1,1)f(\alpha,\gamma)\,d\alpha\,d\gamma=v(1,1)$. The right hand side is:

$$\begin{aligned}
&\int_1^2\int_1^2[v(\alpha,\gamma)]f(\alpha,\gamma)\;d\gamma\,d\alpha-\int_1^{\infty}\int_1^{\infty}\left[\int_1^{\alpha}\tfrac{y(\tilde{\alpha})}{\tilde{\alpha}^2}\,d\tilde{\alpha}\right]f(\alpha,\gamma)\;d\gamma\,d\alpha-\int_1^{\infty}\int_1^{\infty}\left[\int_1^{\gamma}\tfrac{c(\tilde{\gamma})}{\tilde{\gamma}^2}\,d\tilde{\gamma}\right]f(\alpha,\gamma)\;d\gamma\,d\alpha\\
&=\int_1^2\int_1^2 vf-\int_1^{\infty}\int_1^{\alpha}\tfrac{y(\tilde{\alpha})}{\tilde{\alpha}^2}f(\alpha)\;d\tilde{\alpha}\,d\alpha-\int_1^{\infty}\int_1^{\gamma}\tfrac{c(\tilde{\gamma})}{\tilde{\gamma}^2}f(\gamma)\,d\tilde{\gamma}\,d\gamma && \text{[Integrate out } \alpha \text{ and } \gamma\text{]}\\
&=\int_1^2\int_1^2 vf-\int_1^{\infty}\int_{\tilde{\alpha}}^{\infty}\tfrac{y(\tilde{\alpha})}{\tilde{\alpha}^2}f(\alpha)\;d\alpha\,d\tilde{\alpha}-\int_1^{\infty}\int_{\tilde{\gamma}}^{\infty}\tfrac{c(\tilde{\gamma})}{\tilde{\gamma}^2}f(\gamma)\,d\gamma\,d\tilde{\gamma} && \text{[Change order of integration]}\\
&=\underbrace{\int_1^{\infty}\int_1^{\infty} vf}_{A}-\int_1^{\infty}\tfrac{y(\tilde{\alpha})}{\tilde{\alpha}^2}(1-F(\tilde{\alpha}))\,d\tilde{\alpha}-\int_1^{\infty}\tfrac{c(\tilde{\gamma})}{\tilde{\gamma}^2}(1-F(\tilde{\gamma}))\,d\tilde{\gamma}\,. && (20)
\end{aligned}$$

Working with A in (20),

$$\begin{aligned}
&\underbrace{\int_1^{\infty}\int_1^{\infty} v(\alpha,\gamma)f(\alpha,\gamma)\,d\alpha\,d\gamma}_{A}\\
&=\int_1^{\infty}\int_1^{\infty}\left[y(\alpha)-t(y(\alpha))-\tfrac{y(\alpha)}{\alpha}\right]f(\alpha,\gamma)\,d\alpha\,d\gamma-\int_1^{\infty}\int_1^{\infty}\left[\tfrac{c(\gamma)}{\gamma}+p(c(\gamma))d\right]f(\alpha,\gamma)\,d\alpha\,d\gamma\\
&-\int_1^{\infty}\int_1^{\infty}\left[\bar{p}(h-d)\right]f(\alpha,\gamma)\,d\alpha\,d\gamma
\end{aligned}$$

$$= \int_1^\infty \left[y(\alpha) - \tfrac{y(\alpha)}{\alpha}\right] f(\alpha)\, d\alpha \; - \int_1^\infty t(y(\alpha)) f(\alpha) - \int_1^\infty \left[\tfrac{c(\gamma)}{\gamma} + p(c(\gamma))d\right] f(\gamma)\, d\gamma - \bar{p}(h-d).$$

Now budget balance for the government (equivalently resource balance in the consumable commodity) requires $\int_1^\infty t(y(\alpha)) f(\alpha) = S$, where S is some exogenously required surplus (or allowable deficit, if negative). Further, by our implicit assumption that damages and recovery are coupled and legal costs are nil, average damages paid equal average damages received. Hence, the chain of equalities continues as:

$$= \int_1^\infty \left[y(\alpha) - \tfrac{y(\alpha)}{\alpha}\right] f(\alpha)\, d\alpha \; - \int_1^\infty \left[\tfrac{c(\gamma)}{\gamma} + p(c(\gamma))h\right] f(\gamma)\, d\gamma - S.$$

Substituting back into (20) yields

$$v(1,1) = \int_1^\infty \left[(\alpha - 1) - \tfrac{1}{\alpha h(\alpha)}\right] \ell(\alpha) f(\alpha)\, d\alpha - \int_1^2 \left[\left(1 + \tfrac{1}{\gamma h(\gamma)}\right) x(\gamma) + p(\gamma x(\gamma))h\right] f(\gamma)\, d\gamma - S \qquad (21)$$

where $h(\alpha) = \frac{f(\alpha)}{1-F(\alpha)}$ and $h(\gamma) = \frac{f(\gamma)}{1-F(\gamma)}$ are the *hazard rates* for marginal distributions of α and γ. This expression, (21), is what we will use for $v(1,1)$.

Now we step back and notice that together (18) and (21) allow us to express $v(\alpha,\gamma)$ solely in terms of $\ell(\alpha)$ and d. Modulo incentive constraints, we may then proceed as if the social planner chooses these two objects. As is well known the incentive constraint for $\ell(\alpha)$ boils down to the requirement that it be non-decreasing.[19] The problem in these terms is:

Choose d and piecewise continuously differentiable $\ell(\alpha)$ *to*

MAXIMIZE

$$\int_1^\infty \int_1^\infty W(v(\alpha,\gamma)) f(\alpha,\gamma) \qquad (22)$$

where

$$v(\alpha,\gamma) = \mu(\alpha,\gamma) + v(1,1) \qquad (18)$$

$$\mu(\alpha,\gamma) = \int_1^\alpha \tfrac{\ell(\tilde{\alpha})}{\tilde{\alpha}}\, d\tilde{\alpha} \; + \int_1^\gamma \tfrac{x(\tilde{\gamma})}{\tilde{\gamma}}\, d\tilde{\gamma} \qquad (18)$$

$$v(1,1) = \int_1^\infty \left[(\alpha - 1) - \tfrac{1}{\alpha h(\alpha)}\right] \ell(\alpha) f(\alpha)\, d\alpha - \int_1^\infty \left[\left(1 + \tfrac{1}{\gamma h(\gamma)}\right) x(\gamma) + p(\gamma x(\gamma))h\right] f(\gamma)\, d\gamma - S \qquad (21)$$

subject to

$x(\gamma)$ *minimizes* $x + p(\gamma x)d$ (23)

$\ell(\alpha)$ *is non-decreasing.* (24)

$0 \le \ell(\alpha) \le H$ (25)

We assume that W is continuously differentiable and individualistic ($W' > 0$). As discussed in the text, the social planner is equity concerned to the extent that W is concave, i.e. the extent to which

[19] The requirement that labor supply be non-decreasing and that first order conditions hold is equivalent to the requirement that agents optimize with respect to their announced types. The requirement that first order conditions hold is equivalent to the envelope condition used in the main text. For details, see Fudenberg and Tirole (1990), Chapter 7.

$W'(v)$ is decreasing in v. If, for example, W has the form $W(v)=\frac{v^{1+\phi}}{1+\phi}$ where $\phi \in \Re$, then the more negative ϕ the more relatively concave W. Moreover, in the limit as ϕ approaches $-\infty$ the welfare function approaches that of the Rawlsian.[20]

8.1 Optimal Tax Schedule

Writing $\lambda(\alpha)$ for the multipliers associated with constraint[21] (24), the first order condition with respect to $\ell(\alpha)$ is:

$$\iint\left(W'(v)\left(\tfrac{dv(1,1)}{d\ell(\beta)}+\tfrac{dv(\alpha,\beta)}{d\ell(\beta)}\right)+\lambda(\beta)\right)f=0\,.$$

Inspection of (18) and (21) show that the left hand side is not a function of $\ell(\beta)$. Thus, $\ell(\beta)$ is either 0 or H at an optimum. Since $\ell(\beta)$ must be non-decreasing, there must be some critical α^c such that $\ell(\alpha)=0$ all $\alpha<\alpha^c$ and $\ell(\alpha)=H$, all $\alpha>\alpha^c$. See Section 4.2.1 for a tax system that induces this labor supply pattern.

8.2 Optimal Damages Rule: First Order Condition for General W

We now turn to the optimal level of damages d. We will derive the generalization of (8). Returning to the original expression for $v(\alpha,\gamma)$ and applying the envelope theorem yields, as in Appendix A, $v_d=\bar{p}-p-\bar{p}_d(h-d)$. Differentiating the objective (22) with respect to d and then applying the techniques in Appendix A gives:

$$SWF_d=\underbrace{-\bar{p}_d(h-d)\overline{W}'}_{\text{Efficiency Effect}}\underbrace{-\operatorname{cov}[W'(v),p]}_{\text{Equity Effect}} \tag{26}$$

In comparing this expression to equation (8) in the main text, the Equity Effect requires some additional discussion. It is the covariance between individuals' accident probabilities and their *marginal social welfare weights*, $W'(v(\alpha,\gamma))$. When the planner is equity conscious, W' declines in well-being. When the more well-off are more accident prone, p <u>increases</u> in well-being and the covariance $\operatorname{cov}[W'(v),p]$ is negative. This corresponds to the case in which $\operatorname{cov}[v,p]$ is <u>positive</u>. On the other hand, when the more well-off are more careful, p and W' move together and $\operatorname{cov}[W'(v),p]$ is positive. This corresponds to the case in which $\operatorname{cov}[v,p]$ is negative.

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[20] For more details, see Atkinson and Stiglitz (1980).

[21] With general welfare functions it is not a foregone conclusion that labor supply will be non-decreasing, if we solve the problem ignoring that constraint. Therefore, we add this extra multiplier.

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