NOTES AND COMMUNICATIONS

Moral Hazard and Moral Imperative: Comment

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In a recent article in this *Journal,* Wu and Colwell (1988) seek to describe how the optimal level of safety production chosen by an individual is determined. Their objective is to "... handle questions of moral hazard, and moral imperative in a simpler and more heuristic manner than the previous literature" (p. 101). The authors attempt to determine how the marginal benefit of safety production is impacted by various parameters for the cases of full and partial insurance coverage. The conditions under which the presence of insurance will lead to more safety production (moral imperative), and when it will lead to less safety production (moral hazard), are examined.

While the questions explored by Wu and Colwell are of interest, many of their conclusions are incorrect, as several of their proofs contain a fundamental error. In particular, the discussion of partial insurance (section III of their paper) is fatally flawed, as the proofs of Propositions 1 and 2 are both invalid. Thus, the comparative statics results which follow (section IV of the paper) do not necessarily hold for the case of partial insurance coverage. Furthermore, a portion of their comparative statics results is also invalid for the case of full insurance coverage.

The problem in their analysis occurs when equalities are incorrectly treated as identities. The mistake first appears in the proof of Proposition 1, which is contained in Appendix A (p. 116). The incorrect demonstration begins with equation A.1, which is reproduced below using the authors' notation.

$$p'(U_1 - U_0) = [(1 - p)U_1' + pU_0'](1 - \alpha)L\pi'.$$

The function U_0 represents utility in the event that a fixed loss (L) occurs, and thus can be expressed as $U_0 = U_0[W - \alpha\pi(s)L - (1 - \alpha)L - C(s)]$, where W is initial wealth, α is the insurance coverage ratio, C(s) is the cost of safety production, $\pi(s)$ is the price of insurance, and s is the amount of safety production. If a loss does not occur, utility is $U_1 = U_1(W - \alpha\pi(s)L - C(s))$. The probability of a loss (p) depends on the level of safety production, and is written as $p = p(s)$.

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Wu and Colwell state that the above "... equality implies that the derivatives of both sides of (A.1) with respect to α are equal" (p. 116). Taking the derivative Wu and Colwell obtain equation A.2 (p. 116), which is repeated below.

$$p'[U_1'(-\pi L) - U_0'(1-\pi)L] = -L\pi'[(1-p)U_1' + pU_0']$$
$$+ (1-\alpha)L\pi'[(1-p)U_1''(-\pi L) + pU_0''(1-\pi)L]$$

This equation is not correct. Both sides of equation A.1 depend on s, α, L, and W, and for a particular vector (s, α, L, W) the equality may hold. However, and this is the important point, equation A.1 is not an identity, and it does not hold for all α. Therefore, it is wrong to claim that the derivative of the left-hand side with respect to α will be equal to the derivative of the right-hand side.

To help clarify the point, consider a simple economic demand and supply model where quantity demanded and quantity supplied are both expressed as functions of price, denoted by $Q_d = F(P)$ and $Q_s = G(P)$. At the point of intersection of the two curves $F(P) = G(P)$. But, obviously it would be incorrect to assert that, at the point of intersection of the demand and supply curves, $F'(P)$ is equal to $G'(P)$. As a result, equation A.2 does not hold. The proof of Proposition 2 is also incorrect, since it too makes use of equation A.2.

The authors make the same mistake when addressing the impact of changing the size of the loss (L) on the marginal benefit of safety production. The demonstration found in footnote 9 begins with the equality (p. 113)

$$(U_1 - U_0)/[(1-p)U_1' + pU_0'] = L,$$

where the arguments of the functions U_1, U_0 and p remain unchanged from above. The derivatives of both sides of this equation with respect to L are calculated and set equal to one another. Once again, this procedure is correct only if the above equation is an identity which holds for all L. However, this would imply $B = 1$ for all L. (The variable B is defined by the authors to be the left-hand side of the above equation divided by L.) But B is not independent of L. As stated by Wu and Colwell (p. 108), "given the size of loss L, B reflects the marginal benefit of increasing safety." The error is repeated again in footnote 10, and hence one cannot conclude as the authors do that "the size of the loss does not affect the regions of moral hazard and moral imperative" (p. 113).

The authors' remark that the amount of insurance coverage a person will desire depends (p. 115) "... on the probability of hazards, insurance premium, and the utility function" is obviously true. Furthermore, one cannot quibble with the authors' assertion that "... loss, safety device effectiveness, and premium loading can affect the incentives for safety production" (p. 115). However, it is not enough for an economic model to simply restate the obvious. It is important to analyze precisely how these factors influence the marginal benefit of safety production. Wu and Colwell attempt to determine the direction of these effects, but because of the aforementioned mathematical errors most of the interesting questions remain unanswered.

References

1. Wu, C. and P. F. Colwell, 1988, "Moral Hazard and Moral Imperative," *Journal of Risk and Insurance*, Vol. 55: 101–17.