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Comments

The Calculation of Returns to Research in Distorted Markets: Reply

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Before turning to the comment by Voon and Edwards, I would like to correct a mistake in the original paper (Oehmke, 1988).[1] I incorrectly reported the parameter values for example 2. The correct values are $\alpha = 2 \times 10^5$, $\sigma = 0.6$, $\varrho = 1 \times 10^{-4}$, $\zeta = 6 \times 10^7$, $\epsilon = 0.5$ and $s = 40.0$. The free-market equilibrium price is 178.6 and the equilibrium price in the subsidized marked is 157.9. The ROR's are as reported in the original paper: method 1, 33%; method 2, 42%; and method 3, negative returns.

I will now address the comment by Voon and Edwards (VE). The most important discrepancy between my original paper and the comment is that I discussed the marginal rates of return (ROR) to a research project in the presence of policy distortions, while VE focus on the average internal rates of return (IRR). The use of average rates is clearly problematical when applied to optimality questions and policy prescriptions, although to their credit VE stay away from normative analysis. Nevertheless, the intuition that VE develop based on IRR analysis is misleading when applied to marginal ROR calculations, since the ROR is constant (and hence equal to IRR) only in pathological cases.

The application of IRR analysis is particuliarly illusive when quantifying the size of policy effects on research ROR's. The point of my original paper is that interactions between research and price interventions have an important effect on the ROR to research. These interactions depend on the manner in which research shifts the supply curve, and on nonlinearities in the effects of this shift on market price, social surplus and budget expenditures. They

[1] This error was first pointed out to me by Donald MacLaren of the University of Melbourne.

cause the ROR to be nonconstant and thus to differ from the IRR.[2] Hence VE's application of IRR analysis to results on ROR's essentially assumes away any interactions between research and price policy. So of course VE conclude (erroneously) that these interactions have small effects.

The second major discrepancy between the paper and the comment is a methodological difference: I use numerical simulation, while VE use graphical analysis. Graphs do not convey enough information to yield sound intuition about relative sizes of ROR's. I incorporated graphs into the paper to help visualize the hypothesized markets. I drew the diagrams with discrete shifts in the supply curve because it is very hard to draw infinitesimal shifts (the shifts are infinitesimal because for marginal ROR analysis we focus on infinitesimal changes in research expenditures). Therefore the diagrams should not be used as tools to measure the size of certain areas relating to marginal ROR calculations, rather they should be interpreted as pictorial descriptions of the policies considered. The derivation of numerical results from graphical analysis is particularly inappropriate. Recall that the ROR is determined as the solution to a nonlinear, intertemporal equation [equation (1) in the original paper]. It is extremely difficult to solve this equation in one's head to estimate the ROR for a particular example by eyeballing a static diagram with generic suply and demand curves, such as those which I or VE use. To obtain numerical results, numerical simulation is appropriate.

Even with the assumptions I made to simplify equation (1), the limitations of graphical analysis persist. For example, consider VE's Fig. 3. The shift from S to S' is a discrete representation of an infinitesimal shift. Hence one should not draw intuition from visual observations of the size of the area between the S and S' curves. Yet this is exactly what VE do. They claim that 'it can be shown by accurate graphing that are *fcde* is in fact very small compared with area (O*je-mhjk*) [p. 81],' But area O*je* is the discrete representation of the infinitesimal area between S and S', and hence inaccurate. Thus conclusions based on this graphical representation are inapplicable.

Moreover, the assertion that fcde is small is counter-productive even in a discussion of IRR's. Area *fcde* represents the additional cost of the price policy due to the research shift. To assume that this area is small is to assume

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[2] In example 1 the linearity of $\alpha(R)$ and the exogenous determination of price imply that the ROR is a constant function of research expenditures, and hence equal to the IRR. This is perhaps why VE agree with the results of example 1. Examples 2 and 3 introduce more subtle and more complex interactions between research and price policy, through the dependence of prices on the supply shift. The ambitious reader can reveal the influence of these interactions on the ROR's by calculating δ (ROR)/δ(Research) and δ(ROR)/δ(Price Policy) for the three examples.

that interactions between research and price policy are unimportant. This is an unacceptable assumption when investigating the magnitude of these interactive effects.

The difficulty of drawing correct conclusions from graphical representations and the unsuitable assumptions used by VE is highlighted by a comparison of Alston et al. (1988) with the comment.[3] Even though the geometric approach of VE follows that of Alston et al. (VE, p. 77), the conclusions are very different. The argument in the final paragraph of the VE comment is essentially that since the IRR's with and without policy interventions are the same, these price policy interventions don't affect government incentives for investment in research. However, the final paragraph of Alston et al. is very different: 'By changing the size and distribution of benefits from research, price policies change the incentives of governments and various interest groups to invest in research. . . . our results indicate the potential for price distortions to contribute to distortions in research investments when such investments depend on the size and distribution of research results (Alston et al., 1988, p. 288).'

Consequently I conclude that the appropriate methodology for examining the quantitative effects of price policies on research ROR's is numerical simulation, as used in the original paper, and I maintain the conclusions therein. Interactions between research and price policy are important factors affecting research ROR's, and neglect of these interactions can impart an upward bias to estimated ROR's. This upward bias can be severe, and can contribute to the explanation of the estimated high ROR's to agricultural research.[4]

However, I would like to salvage something from the comment. VE present results based on linear supply and demand curves and parallel supply shifts. They correctly argue that for this special case, in my examples 1 and 2 there is no difference between the IRR when the calculation incorporates policy interactions and the IRR when it does not.[5] This does not support the argument that interactions between research and price policy are unimportant in the evaluation of research: it is easy to find counterexamples (for example, target prices in a closed economy). However, it does extend the lessons of Lindner and Jarrett (1978) and Rose (1980), that the form of the

[3] Recently Miller and Tolley (1989) also find important interactions between price policy and technical change.

[4] I did not intend to claim that this upward bias is the sole cause of high ROR estimates, and have argued elsewhere that other factors also contribute to the magnitude of these numbers (Oehmke, 1986; Oehmke and Yao, 1990).

[5] A similar result holds for ROR when $\alpha(R)$ is linear in R, although the ROR differs from the IRR and the linearity of supply and demand is irrelevant for either result.

supply shift is important in the evaluation of research. The extension is that the effects of any particular form of the supply shift on social benefits and costs in a distorted market may be very different for different types of price policy interventions.

Since the form of the supply shift may be related to the type of research undertaken (Lindner and Jarrett), interactions between supply shifts and price interventions raise interesting questions about the joint evolution of optimal price and research policy. For example, given a particular price policy, should research of a particular type be emphasized because it results in a 'better' form of supply shift? If a research program is supposed to be (wholly or partly) financially sustainable through taxes on the output market, how does the optimal tax policy change as the type of research program changes?

To give this point more substance consider a closed-economy, developing country. This country subsidizes consumption of a staple food by guaranteeing consumers that they can purchase as much as they want at price $\underline{P}$.[6] In Fig. 1 the supply and demand curves are represented by S and D, and the price policy is depicted by the horizontal line at $\underline{P}$. At the subsidized price consumers demand quantity Q_0, and producers require a price P_0 to produce this quantity. The government costs of the subsidy are thus $(P_0 - \underline{P})Q_0$. Now suppose that an investment in research project # 1 leads to a parallel shift in the supply curve, represented by S'. The producer price falls to P_1

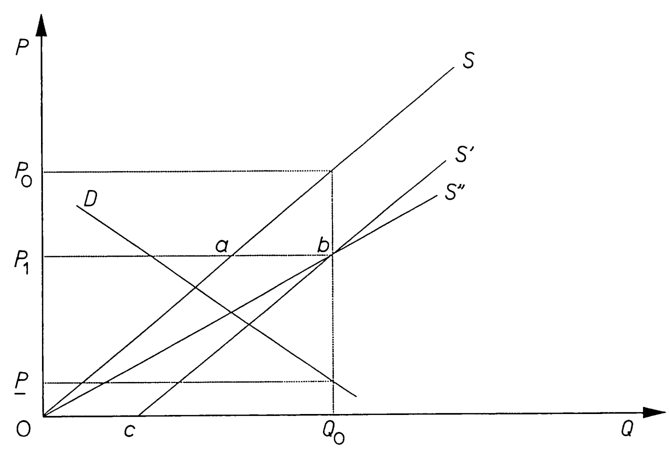

Fig. 1. Parallel supply shift is preferable.

[6] In this case $dG/dR_0 < 0$, so that the price intervention increases the returns to research. Thus this example is opposite to those studied in the original, and methods 1 and 2 of calculating ROR's would provide underestimates of the true ROR.

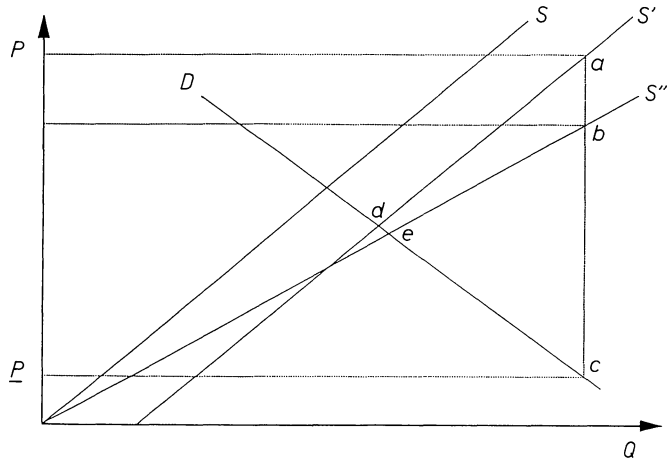

Fig. 2. Proportional supply shift is preferable.

and government costs fall to $(P_1 - \underline{P})Q_0$. Producers' surplus increases by the area Oabc. Now suppose that a comparable investment in research project # 2 causes a proportional shift in supply, represented by curve S''. This has the same effect on producer price and government costs as did the parallel shift. The increase in producers' surplus is now represented by area O*ab*, which is smaller than with the parallel shift: in this case it appears that project #1 is the preferred project. However, Fig. 2 depicts a situation in which the reverse holds. Figure 2 replicates the supply curve and price policy form Fig. 1, but the demand curve lies farther to the right. This means that the proportional shift in suply leads to a greater reduction in goverment price policy costs than does the parallel shift, so that in this case research project #2 would be preferable. The easiest way to see this is note that the deadweight loss after the parallel shift, area acd, is greater than the deadweight loss after the proportional shift, area bce. Hence the preferred type of research may be influenced by the nature and degree of the price intervention. While this simple example only scratches the surface of the question, hopefully it points out the need for further work on the evolution of jointly optimal research and price policy.

References

Alston, J.M., Edwards, G.W. and Freebairn, J.W., 1988. Market distortions and benefits from research. Am. J. Agric. Econ., 70: 281–288.

Lindner, R.K. and Jarrett, F.G., 1978. Supply shifts and the size of research benefits. Am. J. Agric. Econ., 60: 48–56.

Miller, T. and Tolley, G.S., 1989. Technology adoption and agricultural price policy. Am. J. Agric. Econ., 71: 847–857.

Oehmke, J.F., 1986. Persistent underinvestment in public agricultural research. Agric. Econ., 1: 53 – 65.
Oehmke, J.F. and Yao, X., 1990. A policy preference function for government intervention in the U.S. wheat market. Am. J. Agri. Econ. forthcoming.
Rose, R.N., 1980. Supply shifts and research benefits: Comment. Am. J. Agric. Econ., 62: 835 – 837.