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Comments

The Calculation of returns to research in distorted markets: Comment

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ABSTRACT

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In a recent article, Oehmke reported that a high internal rate of return for investment in research when the interaction between research and price policy costs was disregarded could become very low or even negative when the effects of research on the costs of price policy were considered. In this paper, the social returns from research in the presence of the price policies considered by Oehmke are reexamined using a simple geometric approach. The analysis suggests that an output subsidy in a small importing economy, an output subsidy in a closed economy, and a target price in a large exporting economy will – on Oehmke's assumptions – cause only small reductions in the internal rate of return from investment in research. This implies that the apparent underinvestment by governments in agricultural research cannot be explained away by a large upward bias, known to governments, in measured rates of return due to failure to account for interactions between research and the costs of price policy measures.

Introduction

In a recent article, Oehmke (1988) endeavoured to demonstrate that failing to allow properly for price policy distortions can cause serious bias in calculating the internal rate of return (IRR) from research. Specifically, Oehmke reported that where research increases the expenditures for price policy interventions, the IRR was biased upwards unless the interactions between research and price policy costs was incorporated in the measurement of research benefits. Moreover, Oehmke found that a high IRR for investment in research when price policy interaction were disregarded could

[1] A negative IRR means that the increased budged costs of price intervention more than outweigh any increases in producer plus consumer surplus due to research.

become very low or even negative[1] when the effects of research on the costs of price policy were considered.

Our main purpose in this comment is to reexamine the social returns from research in the presence of those price policy interventions which were considered by Oehmke. Oehmke considered three examples: an output subsidy in a small, open economy; an output subsidy in a closed economy; and a target price in a large, open economy. The reexamination leads us to dispute Oehmke's findings that high IRRs in the absence of price policies (or when interactions between research and the costs of price policy are disregarded) become low or negative ones in the presence of price policies (or when interactions with price policies are included in assessing IRRs). The reexamination also causes us to find unconvincing the suggestion that the failure of governments to increase outlays for agricultural research is due to their recognition that properly measured social IRRs in distorted markets are much lower than the calculated high social IRRs.[2]

Rate of return formula

The aims in this section are to show mathematically the effects that price policies have on IRRs calculated using a conventional IRR formula, and to show that these effects can be expressed simply in terms of relationships between changes in welfare effects on producers, consumers and taxpayers (government).

In the absence of price policies, the social returns are the economic surplus gains from research and the social costs are the direct research expenditures. The IRR is defined as that rate *(r)* which results in the following equality:

$$\sum_{t=0}^{T} R_t (1 + r)^{-t} = \sum_{t=0}^{T} C_t (1 + r)^{-t} \qquad (1)$$

where R_t is the estimated social benefits in year t, C_t is the estimated costs of research and development in year t, r is the internal rate of return, t depicts the time parameters, and T is the year that research ceases to produce returns. Equation (1) can be reduced to the following expression:

$$\sum_{t=0}^{T} \frac{R_t - C_t}{(1 + r)^t} = 0 \qquad (2)$$

where all terms are defined as above.

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[2] Alan Lloyd has pointed out to us an additional reason for skepticism about the suggested explanation of why governments do not spend more on agriculture research. This is that some findings of high rates of return to research have been made by researchers who allowed appropriately for the effect of market distortions.

To examine the effects of price policies on the IRR formula, we assume that research is the only cause of shifts in supply. Research is assumed to occur instantaneously at time $i = 0$, and to exert its full impact on shifting the supply curve immediately. With these assumptions, which were made by Oehmke, $R_{t_1} = R_{t_2} = (PS_{t_1} + CS_{t_1}) = (PS_{t_2} + CS_{t_2})$ for t_1, $t_2 \geq 0$. Representing the change in total government expenditures by G and the direct research expenditure by R, we have $G_0 = G_t + R_0$ for $t \geq 1$. Replacing $(1/1 + r)^t$ term by λ^t, the IRR equation can be expressed as:

$$\sum_{t=0}^{T} \lambda^t (PS_t + CS_t - G_t) - \lambda^0 R_0 = 0 \tag{3}$$

When $|\lambda| < 1$, $\Sigma_{t=0}^{\infty} \lambda^t = 1/(1 - \lambda)$, equation (3) becomes:

$$\frac{1}{1 - \lambda} (PS + CS - G) = R_0 \tag{4}$$

Substituting $(1 + r)^{-1}$ for λ, and solving for r, gives:

$$r = \frac{PS + CS - G}{R_0 - (PS + CS - G)} \tag{5}$$

where PS is gain in producer surplus, CS is gain in consumer surplus, r is the internal rate of return, G is the change in government expenditures due to the supply shift, and R_0 is the direct research expenditures at time $t = 0$.

Equation (5) illustrates the point that r is increasing in PS and CS (i.e. $\delta r/\delta PS$, $\delta r/\delta CS > 0$) but decreasing in G and R_0 (i.e. $\delta r/\delta G$, $\delta r/\delta R_0 < 0$). The effect of price distortions on r is determined by the relative changes in the magnitude of PS, CS and G (i.e. research, in the presence of price policies, affects government receipts or outlays as well as consumers' and producers' surpluses[3]). If $\delta(PS + CS) < \delta G$ with the movement from a free market to a distorted one, then the calculated IRR will be smaller with the distorted than with the free market. In the following section we attempt to show using a simple geometric approach similar to that used by Alston et al. (1988) that $\delta(PS + CS)$ is similar to δG for the three examples considered by Oehmke.

Examples

We confine our attention to comparison of a free market and a market with price policies, with any increases in price policy outlays caused by

[3] R_0 is assumed to be unaffected by the presence of price policies.

research being counted as a cost of research. This corresponds to Oehmke's methods 1 and 3.[4]

Consider Oehmke's first example, a small, open, importing economy. In Fig. 1, D represents market demand and S represents initial industry supply for a traded good. The government provides a per-unit output subsidy of amount s. The subsidy increases the producer's price from P_w to P_w^s, and increases the quantity from Q_0 to Q_1. Research shifts the supply curve from S to S'. With a research-induced supply shift, the quantity produced in the presence of the subsidy is Q_2. The quantity consumed is unaffected by the shift in supply (or by the subsidy). In this case, consumers receive no benefits from research. All the economic benefit, denoted by area O*ab*, accrues to producers. Relative to free trade, the producer plus consumer surplus in the presence of price policy increases by area *abdf*. The downward shift in supply increases the government costs of the subsidy by area *abce*. Since area

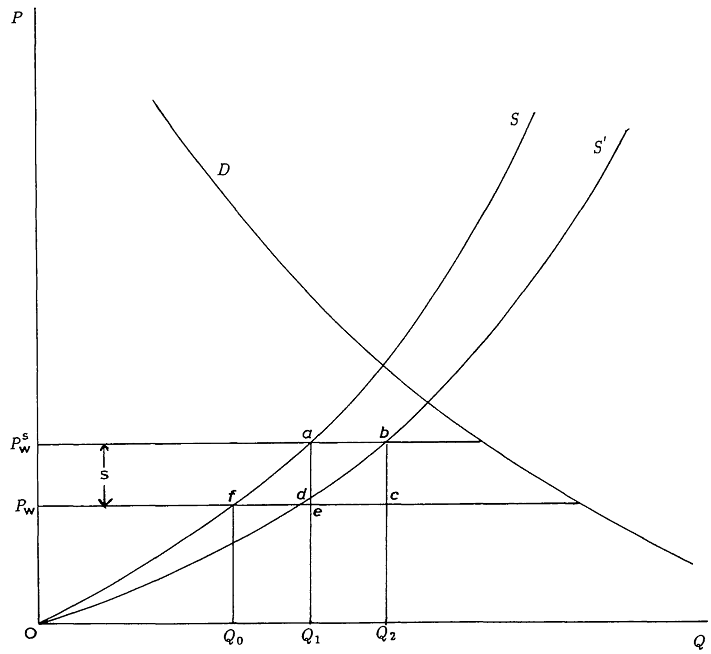

Fig. 1. A small importing economy with an output subsidy.

[4] Method 2 of Oehmke recognises that market price and quantity are affected by the price policy. Using this method, the changes in producer and consumer surpluses are accounted for but the change in government outlays on price policy measure is disregarded in the calculation of IRRs. Since this method is not an appropriate method for assessing research benefits in the presence of a price policy, it will not be included in our comparison.

abdf in the case of a divergent shift is slightly smaller than area *abce*[5], we have demonstrated that, given a constant value of R_0, the calculated IRR with subsidy is only slightly lower than that without price intervention. The results of Oehmke (IRR with subsidy 56% and with a free market 60%) in this example seemed to tally with our analysis.

The disagreement comes in examples 2 and 3. The second example relates to an output subsidy in a closed economy (Fig. 2). Demand and supply curves are the same as those depicted in Fig. 1. For the closed economy case, demand equals supply at market equilibrium. Suppose Q_0 is the initial equilibrium quantity. At the quantity the equilibrium price is P_0, the suppliers produce at price P_0^s, and the difference between these prices is the amount of subsidy s given by the government. The supply shift from S to S' decreases the equilibrium price from P_0 to P_1, and decreases the producer price from P_0^s to P_1^s. Since the unit subsidy is unaffected by the supp-

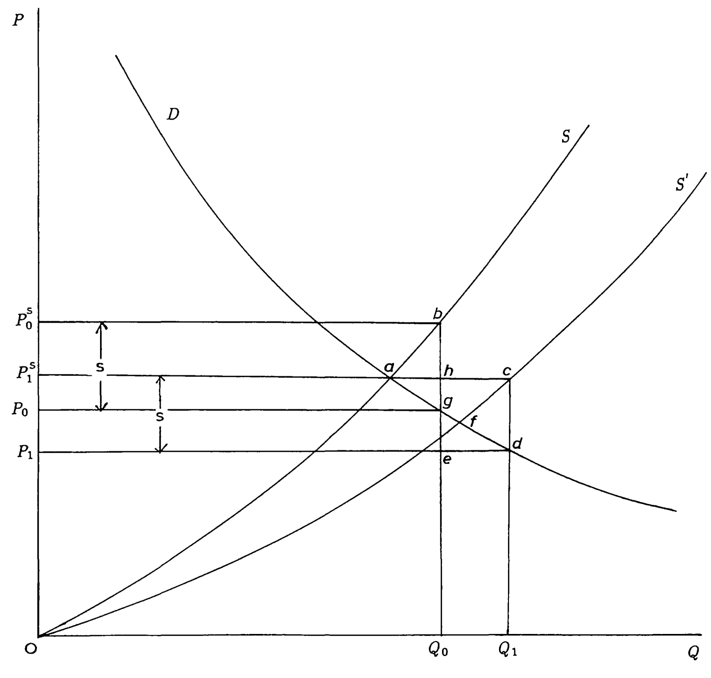

Fig. 2. A closed economy with an output subsidy.

[5] In the case of a parallel shift the extra economic benefit in the presence of subsidy (cf. under free trade) is exactly equal to the extra government costs of the subsidy (see Alston et al., 1988), making the calculated IRR in the presence of a subsidy identical to that under free trade.

ly shift, $P_0^s - P_0 = P_1^s - P_1 = s$. The quantity supplied is increased from Q_0 to Q_1 as a result of the supply shift. With these changes in market conditions, the increase in producer surplus is given by area O*ac* less area $P_0^s baP_1^s$; the increase in consumer surplus is given by area P_0gdP_1; and the increase in government costs of the subsidy is area *hcde*. It has been observed that in the case of a divergent shift in supply, area *abg* is approximately equal to area *fcd*.[6] With some geometrical manipulations (details available from the authors), it is possible to show that the net benefit with subsidy (area O*ac* less area $P_0^s baP_1^s$ plus area P_0gdP_1 less area *hcde*) is approximately equal to area O*af*, which is the social benefit under free market conditions. Alternatively, by comparing the net welfare costs of the subsidy (i.e. the deadweight loss) before and after the research, and attributing the difference as a cost of the research program, the same result can be obtained (see Alston et al., 1988). This implies that the calculated IRR with the subsidy should be positive and similar to that in the absence of the subsidy. Oehmke's findings of an IRR of 33% under a free market and a negative IRR in the presence of a subsidy are inconsistent with the above analysis and are, in our view, erroneous.

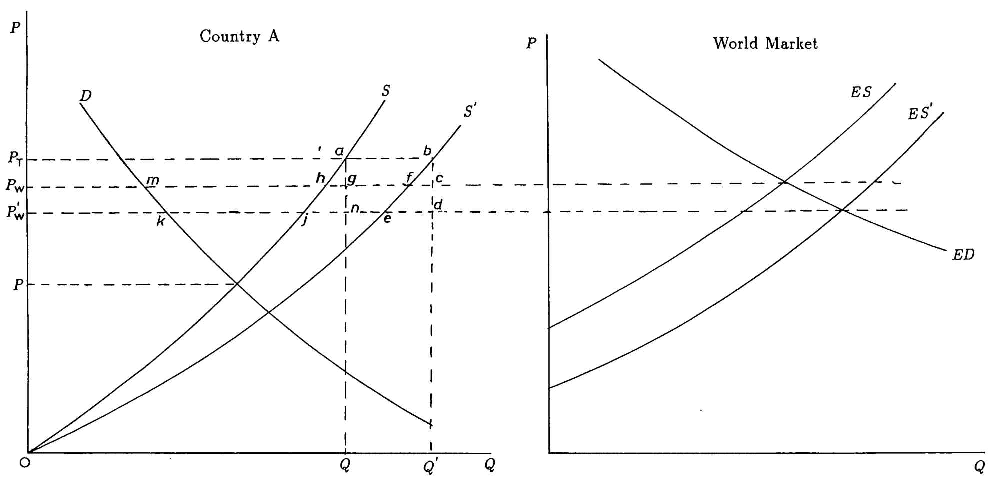

Fig. 3. A large exporting economy with a target price.

[6] For the case of a parallel shift in supply, area *abg* = *fcd* (by the rule of similar triangles) and the net benefit in the presence of price intervention (i.e. *PS* + *CS* − *G*) is therefore exactly equal to the net benefit in the absence of price intervention. In this case the calculated IRR is identical in both situations. Our finding (based on geometrical analysis) is verified by the results of Alston et al. (1988). Using linear and parallel supply shift specifications, they showed mathematically that the extra research benefits to producers plus consumers with the subsidy is equal to the extra government subsidy payments.

The third example is a large, net exporting country that has imposed a target price, supported by government deficiency payments. In Fig. 3, the supply and demand curves for country A are the same as in Figs. 1 and 2. However, instead of an output subsidy, the government fixes a target price P_T; this is assumed to be strictly greater than the world price P_w.[7] The world price is determined by the market clearing equilibrium at which the excess supply in country A (denoted by *ES*) equals the excess demand (denoted by *ED*) in the rest of the world. The supply shift from S to S' in country A shifts the excess supply curve from ES to ES', with the effect that world price declines from P_w to P'_w. In this case, producer surplus in country A increases by area O*ab*; consumer surplus in country A increases by area $P_w mkP'_w$; and the government's cost of price intervention increases by area *abdn* plus area $P_w gnP'_w$. It is observed that area *hag* is approximately equal to area *fbc* (for a parallel shift these two areas are identical). With some geometrical manipulations it is possible to show that the net research benefit with the target price (area O*ab* plus area $P_w mkP'_w$ less area *abdn* less area $P_w gnP'_w$) is smaller than the social benefit under free market conditions (area O*je* less area *mhjk*) by area *fcde*.

Area *fcde* will normally be small compared with area (O*je* − *mhjk*). This will always be so for 'small country' situations, where area *fcde* can be disregarded. Using the 'large country' assumptions made by Oehmke, we calculated that the drop in world price due to the supply shift is small (approximately 6% of the intial world price). With a relatively small change in world price and a small difference between the world price and the target price as assumed by Oehmke, it can be shown by accurate graphing that area *fcde* is in fact very small compared with area (O*je* − *mhjk*). Since area *fcde* is very small, we would expect the calculated IRRs under the target price to be only marginally lower than the IRRs (16% and 39% were the results obtained by Oehmke for the two sets of parameters assumed) under the free market. The extremely small and even negative IRRs reported by Oehmke are again inconsistent with our analysis and, in our view, are incorrect. Furthermore, making the assumptions of linear supply curves and a parallel supply shift used in much work on research evaluation (e.g. Rose, 1980; Edwards and Freebairn, 1984), it can be shown that with other assumptions corresponding to those made by Oehmke, the IRR will be little lower with a target price than with a free market.

[7] For a large exporting country, the world price is likely to be significantly higher than the domestic market-clearing equilibrium. The model applies so long as P_w lies above P (see Fig. 3).

Conclusion

Our analysis suggests that an output subsidy in a small importing economy, an output subsidy in a closed economy, and a target price in a large exporting economy will, on Oehmke's assumptions, cause only small reductions in the IRR from investment in research. This applies also for some other types of market distortions, including taxes/subsidies on imports or exports.[8] Use of a linear specification of supply and demand and of a parallel shift in supply due to research would give identical IRRs for free markets and for markets distorted by output or trade taxes/subsidies in small country and closed economy situations.

The finding that properly measured IRRs in distorted markets are often similar to IRRs under free market conditions has an important implication for attempts to rationalise the apparent underinvestment in agricultural research. It means that the underinvestment cannot be explained away by a large upward bias, known to governments, in measured rates of return due to failure to account for interactions between research and the costs of price policy measures.

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[8] For some price policies, however, the calculated IRRs can be substantially different from those with a 'no policy' base. In the case of an output quota, for instance, the calculated IRR can be substantially lower than with a free market; however, it will be strictly positive in value. In the case of a price equalization scheme, on the other hand, the calculated IRR will be larger than that obtained under a free market.