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A NOTE ON THE SOCIAL RETURNS TO PRIVATE R&D

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The seminal work of Schultz (1953) and Griliches (1958, 1964), along with more recent efforts by Peterson (1967, 1971), Evenson (1967), Schmitz and Seckler (1970), Bredahl (1975), and others have shown that investment in agricultural research has yielded a high social rate of return in the United States.[1/]

Although private investment in agriculturally related R&D by farm supply firms has been taken into account in most of these studies by adding rough estimates of private research to the public expenditures, we have virtually no independent information on the specific contribution of private R&D efforts relating to agriculture.[2/] We can be certain that the private rate of return to this investment is at least as great as the return on alternative investments, else it would not be carried out. But is the social rate of return to private R&D high enough to deem this investment socially profitable?

I shall argue in this note that in spite of our lack of empirical estimates of the social rate of return to private R&D, we can be assured that over the long run this investment also is profitable from society's point of view because the social return must be greater than the private return.

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Private and Social Returns Defined

A. Private Return

It will be useful at the outset to define the meaning of "private" and "social" returns as they relate to private R&D. Private returns are defined as the additional net earnings which the firm is able to capture by investing in R&D. Additional net earnings in this case are defined as the additional sales that result from R&D less associated costs such as added raw materials, interest and depreciation expense on new plant and equipment, etc. that may be required to produce and market the products or services that result from R&D. Of course the associated costs do not include the R&D expenditures. In the context of a cash flow table, the R&D costs are the cash outflows while the additional net earnings (added gross sales less associated costs) represent the net cash inflows.

Investment in R&D is profitable for the firm if the discounted present value of the stream of added net earnings is equal to or greater than the accumulated R&D expenditures using the rate of interest on borrowed funds or the opportunity cost of capital on equity funds as the discount rate. Or we could also say that R&D is privately profitable if the internal rate of return to this investment is equal to or greater than the interest paid on borrowed funds or the opportunity cost of equity funds.

This is not to say that <u>all</u> private R&D turns out to be profitable. No doubt all firms which conduct R&D have invested in projects which have turned out to be unprofitable. Indeed it is quite possible that

during a specific period the entire R&D effort of certain firms have turned out to be unprofitable (Mansfield, 1974). In this sense R&D is no different than any other investment. No one can be absolutely certain of the payoff until the returns have come in. Investments, R&D or otherwise, are made if the expected discounted returns are greater than the accumulated costs. Indeed, in most cases it is not likely that even the accumulated cost of an R&D project will be known until after the project has been completed. Over the long run, however, the profitable projects must more than offset the unprofitable ones, else the firm will discontinue R&D or go out of business entirely.

B. Social Return

In our efforts to measure the rate of return to public research, we defined the social returns as the value of additional output that is forthcoming because of the research. Traditionally we measured the social returns as the "consumer surplus" or area between the old and new supply curves bounded on the top (or right) by the demand curve (Griliches 1958, Peterson 1967). It would seem logical to define the social returns to private R&D in the same manner. Therefore we define the social returns to private R&D as the value of the additional output that is forthcoming because of R&D as measured by this area of consumer surplus.

Why the Social Returns Exceed the Private Returns

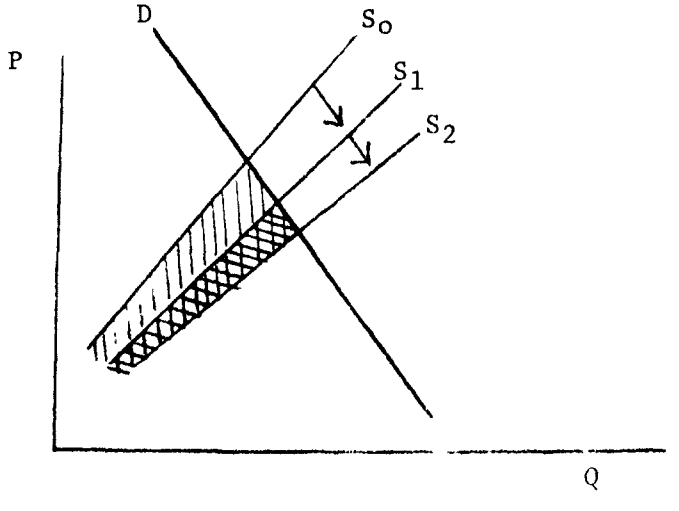
In order for farmers to adopt new or improved inputs made possible by private R&D, the VMP of the inputs in terms of agricultural output must be greater than their respective prices. In other words, the adoption of new inputs must reduce production costs from what they would

otherwise be. If not, farmers would continue to use the old inputs or technology.

We also can be certain that the prices of the inputs must include a return not only to the R&D which made possible the production of the inputs but also a recoupment of the R&D costs which did not result in a saleable product.[3/] This is the only way private firms can capture a return to their R&D. Input prices must exceed their pure production costs by at least enough to provide a normal return on the investment in R&D, otherwise the R&D will not be done.

As farmers adopt the new, more productive inputs and unit costs begin to decline, the supply curve of agricultural products shifts to the right as illustrated by the shift in supply from S_o to S_1 in Figure 1. It is this shift in the supply curve that gives rise to the conventional measure of consumer surplus or social returns, represented by the single line shaded area in Figure 1.

Figure 1. Social Returns to Private R&D



It is important to recognize, however, that the reduction in production costs to farmers and the resulting shift in supply from S_0 to S_1 does not reflect the full increase in output that has resulted from the R&D. Part of the increase in output (MPP) stemming from the use of new, more productive inputs is covered up by that part of the price increase that represents a private return to private R&D. Thus if we measure the shift in supply by the reduction in production costs, we will understate the full contribution to output of private R&D.

A simple numerical example will illustrate the point. Let there be one variable input whose MPP (at a given quantity) doubles because of R&D. Assume the price of the input rises by 50 percent but half of the price increase is a return on the R&D that made the increase in MPP of the input possible. The percent change in marginal cost (shift in the supply curve) will be 25 percent when the private return to the R&D is included in the price. But the shift in supply would be 37.5 percent if the input price did not contain a private return to the R&D. The example is summarized in the following table.

	MPP	Input price	MC	% MC
Initial situation	100	$100	$1.00	-
Price includes R&D cost	200	150	.75	-25
Price excludes R&D cost	200	125	.625	-37.5

If we wish to treat private R&D the same as we treat public research from the standpoint of measuring social returns, then we should include that part of the contribution of private R&D which reimburses the private firms for the cost of the R&D, the double line shaded area in Figure 1.

Hence the relevant supply curve is S_2 in Figure 1 and the area of consumer surplus should include both the single and double line shaded areas. In terms of the above example, the relevant supply curve would be that which exhibited a 37.5 percent shift rather than the 25 percent change.

If we neglect to measure the consumer surplus represented by the double line shaded area in Figure 1, it would amount to double counting the cost of private R&D when assessing the social rate of return to this investment. The cost would be included once on the cash outflow side, and would appear again on the return side as a reduction in cash inflow (social returns). Such a procedure would be comparable to subtracting the cost of public research from its returns before matching its costs against returns in order to compute a benefit/cost ratio or internal rate of return. Of course, this procedure is not done in evaluating the profitability of any investment.

Because the private returns to private R&D are included within and are a subset of the social returns, for the industry as a whole the the social returns to private R&D must be greater than the private returns.[4/] Unless the marginal cost of producing the output using the improved input is lower than the marginal cost of production using the traditional input, the new input will not be adopted and there will be no private returns or social returns. In order for there to be private returns the total area between S_o and S_2 in Figure 1 must be greater than the area between S_1 and S_2 . Otherwise there will be no incentive for farmers to adopt the input.

The same reasoning applies to the case where R&D reduces the cost of producing an input of constant quality, e.g. nitrogen fertilizer. Even though the price of the input is reduced because of R&D, the price still must include a return to the R&D in question. Hence the observed shift in supply of agricultural products which occurs because of the reduction in costs understates the full contribution of the R&D to output.

Although we can be certain that the private returns to R&D are smaller than the total social returns, the ratio of private to social returns can be expected to vary between inputs and between points in time. A new input which does not have close substitutes and therefore exhibits a relatively inelastic demand (facing the supplier) should yield higher pure profits and a higher private relative to social return, other things equal. However, over the long run, as more and closer substitutes become available, and pure profits are eroded away we would expect the private return to diminish relative to the social return. Of course, "other things" are not usually equal. Thus it is very difficult, if not impossible, to predict in advance which innovations will yield a high social to private ratio. Also the ratio will depend on the point in time (relative to the introduction of the input) the returns are evaluated. The more time that has elapsed, the lower should be the private relative to total social returns. This time should be shortened by the emergence of new inputs which are close substitutes for the input in question. Indeed, for many if not most innovations, it is likely that the private returns to R&D eventually fall to zero while some social returns continue on indefinitely. Such is the fabric of economic growth.

Of course, it is not uncommon for an input to be forced off the market by a new cheaper or more productive substitute input. In this case the social return as well as the private return to the R&D which produced the input will fall to zero. However, this phenomenon is not necessarily bad from the standpoint of the industry or society. Stagnant industries tend not to be very profitable, either privately or socially.

Footnotes

1/ Additional work dealing with agricultural research in other countries include Ardito-Barletta (1970),Ayer and Schuh (1972), Evenson (1974) and Hertford (1975). Also see Peterson and Hayami (1973) for a more complete review of the literature on the economics of agricultural research.

2/ This is probably due to the lack of data on private R&D.

3/ Part of these R&D costs may be failures and part the nondirected or "basic" research conducted by the firm.

4/ Externalities aside. However it is not evident that externalities are more prevalent in private R&D than public research.

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