Identifying Inputs and Generating Outputs:
A Difficult Case

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I. Introduction

In his Ely Lecture to the American Economic Association, Nicholas Georgescu-Roegen characterized Wicksteed's century-old production function (Wicksteed, 1894) - variants of it are still with us - P = F(a, b, c, ...) as a "paradigm of imprecision" Georgescu-Roegen, 1970, p. 1.) What Georgescu meant by this was that such a production function fails to capture the "essential" concept of "process" (Georgescu-Roegen, ibid., pp. 2-3.)

But even if a production function does convey the idea of process, it will still remain a "paradigm of imprecision", and necessarily so, wherever production inside a firm involves two or more persons grouped into a team. Actually, the "paradigm-of-imprecision" characterization should be taken further. For the conventional production function, even if transformed in the manner suggested by Georgescu in order to represent a "process," would still fail to provide a felicitous representation of the contribution to the productive process of the service of workers typically enmeshed in series of (largely implicit) contractual relations with their supervisors and employers, as well as with each other.

Furthermore, Georgescu pointed out, there is a tendency simply to associate the concept process with "change". (Georgescu-Roegen, 1970, p. 2, emphasis added). But change is a notoriously intricate

notion. Georgescu believed that he could deal with these intricacies by making use of "grounded-in-actuality symbolism" (<u>ibid</u>., p. 8.) However, Georgescu's grounded-in-actuality symbolism, as painstakingly meticulous in its attention to <u>physical</u> detail though it was, could scarcely add to one's understanding of the problems of <u>team production</u>.

The objective of the present paper may be described as the shedding of some - hopefully new - light upon what is an obviously complex set of input-output issues.

Section 2 of the paper deals with what we describe as a shift in focus in the literature of the theory of the firm and theory of production . If we may prejudge: this "shift" appears to be very wholesome. It is still with us, and can be brought under the generic descriptive label, "moving out of the black box" (cp Jensen and Meckling, 1976, pp. 306-7.)

Section 3 explores what to many of us are some of the principal problems of team production.

Section 4 deals with what we refer to as the problem of "signing" the Alchian-Demsetz cross partial derivative.

Section 5 offers a brief caveat concerning the paper's objective and concerning, too, a simplifying assumption on team-member preferences.

Section 6 examines "incomplete" contracts.

Section 7 looks into the difficulties of specifying the utility function of a team member.

Section 8 offers the reader the opportunity to switch to what some people might consider a more user-friendly vocabulary and set of concepts.

Section 9 provides a "real-world" class of examples illustrative of the problem set of the paper. It is, moreover, a class of examples which should throw some light on the darker corners of the paper.

Section 10 is a concluding note. instead of being a "conclusion" in the conventional sense, it is a brief inquest into one of the unsettled issues and areas of discomfort left by the paper: namely, our simplifying assumption on team-member preferences.

2. The Shift in Focus

Over the years, attempts to deal with the matters alluded to in the introduction have had the consequence, for the theory of production and the theory of the firm, of shifting the focus insofar as human inputs are concerned, from dealing with these inputs, in a _physical_ sense, coupled with an assumed homogeneity of such inputs and what may generally be described as a static production-function worldview, to the _services_ of the human beings _and_ the contractual arrangements - typically implicit - under which these services are employed.

3. Team Production

Where there is team production - and, surely, virtually all production in the plants of the textbooks as well as "out there" is team production - then, as implied above, there cannot really be said to exist, in such a context, a conventional, static production function, even one which has been refined in an attempt to capture the notion of "process". Thus, that textbook exercise of assuming one factor or factors conceptually "fixed"and another factor "variable" in order to "compute" the marginal product attributable to the variable factor is scarcely a credible one. And, it is not the usual and rigid fixed/variable factor distinction which is the problem here. Rather, it is the failure to recognize the ubiquitousness of team production and, correspondingly, failure to treat as non-separable the relationship between outputs and those inputs of human services which are locked into teams. In brief, where X is output, and Y_i and Y_j are inputs of services provided by two different team members (employees), $\frac{\partial^2 X}{\partial Y_i \partial Y_j} \neq 0$. (Cf. Alchian and Demsetz, 1972, p. 779.)

The key set of phenomena where there is team production - "teamness", let us call it - casts a shadow of doubt upon the existence of the marginal product attributable to that input which is a human service. Various phenomena may be brought under the head, teamness, but for our purposes they really reduce to only one of concern: namely, networking, which is seen here as the necessity of having to work with others, at various levels of the firm's hierarchy, in order to perform. The problems that will

normally be associated with the need to interact will obviously include imperfect information with respect to how a managerial performance will affect the quantity and quality of employee performance (and perhaps vice versa). Likewise, as regards employees, managers typically have imperfect information - or virtually no information - concerning the effects of networking within the various peer groups upon the quantity and quality of individual contributions to the productive process (the Alchian-Demsetz cross partial again, but see, also, Levine, 1994.)

4. Signing the Alchian-Demsetz cross partial

We have already touched upon, approvingly, the Alchian-Demsetz reluctance, in their team production example, to envisage a conventional production function that is separable, logically and empirically, into two functions, one having as an argument factor service Y_i and the other Y_j. Our brief description of that story ended with the cross partial, $\frac{\partial^2 X}{\partial Y_i \partial Y_j} \neq 0$.

But we must move beyond the limits of the problem outlined by Alchian-Demsetz, and broach the vexing question of whether or not it would ever be possible to sign their cross partial. Thus, in a particular production situation, does input Y_i play a beneficial or detrimental role with respect to the overall productive effectiveness of the firm? It may not be possible to tell. That

is, where i and j are two workers on the same rung of the hierarchical ladder, could it be that $\dfrac{\partial^2 X}{\partial Y_i}$ ↑ has the effect $\dfrac{\partial^2 X}{\partial Y_j}$ ↓ ? In other words, does an increment in some activity by i have a depressing effect upon the productivity of j, in which case $\dfrac{\partial^2 X}{\partial Y_i \partial Y_j} < 0$? Now, let us leave the scenarios such as the previous one, in which the action takes place on the same rung of the hierarchial ladder, and consider instead a scenario in which the action or interaction takes place across different rungs. Thus, think of the the case where Y_i is a "monitoring" service provided by a supervisor, and Y_j the "productive" activity of a subordinate, it could be that, in this instance, $\dfrac{\partial^2 X}{\partial Y_i \partial Y_j} > 0$ ⁻ but not necessarily.

5.   **A Caveat**

There is no intention in this paper to examine, or re-examine, the economic theory of teams in the manner, say, of Roy Radner (Radner, 1972) or of Marschak and Radner (Marschak and Radner, 1972.) Furthermore, we shall not follow Radner in assuming that there are differences among team members as regards preferences, where "preference is understood to comprise both tastes and beliefs," (Radner, 1972, p. 189.) Actually, this is simply a definition (a definition, incidentally, which we retain) in Radner's account. Moreover, in Radner's treatment, the following appears as a "fact": "in some cases the members of the [team] may have nearly identical preferences." (Radner, ibid.) Whether the

latter is fact or assumption, in this paper it is an assumption that we shall make.

6. Incomplete Contracts

The problem of signing the Alchian-Demsetz cross partial can be compounded when one introduces the notion of "incomplete" contracts. That is, as Radner has pointed out (Radner, 1996, p. 1361), even in the case of explicit contacts there can be situations in which many contingencies are not covered by the terms of the contract.[1] Obviously, this can introduce additional uncertainty as to exactly how team member i's performance will affect the performance of team member j. In a word, one must deal with probable outcomes, not outcomes, here.

To go beyond Radner: presumably, a comparable set of problems may arise in the case of implicit contracts, where, after all, many contingencies may be said to be untouched by the "intended" and/or "understood" conditions of an implicit contract. And, once again, one is forced to deal with uncertainty and probable outcomes.

7. Specifying the Utility Function of a Team Member

Attempts to specify the (ordinal) utility function of a team member will bring further difficulties to the task of modelling team production. The utility function of a team member will presumably have as its arguments not only the monetary component and the various non-monetary components of the team member's total emolument, but, also, the contents of the social milieu of the team

member's workplace. Now, social milieu together with the non-monetary components of the employee's emolument can be intersecting sets of phenomena, in which case specification of a "crisp" utility function may be difficult, even if we retain our simplifying assumption of no differences among team members with respect to preferences. Would this, then, be a case of trying to specify a crisp function over a fuzzy (imprecise) domain? Yes, quite possibly - and this aside from the question of intersecting sets - if the team member's social environment has become what it is in part because of the intrusion of the inherently imprecise or fuzzy aspects of teamness.

Given, then, a fuzzy decision space facing the team member, what can be said of the latter's ordinal utility function over the alternatives in this space; that is, over bundles of emolument packages and facets of a member's social environment.

More precisely, what may be said of the scope of the logical properties of the team members' preference relations over their alternatives. In other words, as in the neoclassical theory of consumer behaviour, may we say that in this context, too, the decision maker is able to discriminate perfectly among his/her objects of choice? But "classical" preference relations may break down where, as in the present context, the objects of choice are to be found among sets of phenomena comprising bundles of non-monetary emoluments and facets of an ill-defined social milieu. In short, the classical "binary logic" of the species, preference/non-preference, may well become inapplicable here.

We have implicitly dealt with the social milieu as being a source of utility or satisfaction. But some facets of this milieu may be sources of disutility to many employees or team members. If so, then what will emerge as trump in this haze?

Yet another problem: namely, that of determining the net effect of the social milieu, including all the relationships that form part of this milieu, upon the overall productive effectiveness of the plant or firm - a problem that will not go away, even if we believe that we can solve the problem of signing the Alchian-Demsetz cross partial.

8. A Switch to a More User-friendly Vocabulary and Set of Concepts?

If one wishes to equip one's self here with what some might believe is a more user-friendly vocabulary (and set of concepts), then one could abandon descriptions of how imprecision or fuzziness with respect to preference relations or anything else for that matter may affect one's efforts to model team production, and instead, simply speak of <u>uncertainty</u>.

9. A (Hopefully) Clarifying Class of Examples

One might be in a better position to sort things out here if one considers the following examples (Levine, 1994) of a class of inputs of human services that are rather more complex and difficult to measure - and possibly even to identify - than those that are encountered in the standard literature. In the latter, inputs of

employee services are usually implicitly assumed to be, and are indeed more often than not treated as, relatively undifferentiated homogeneous lumps. In contrast, in the following instance a key employee input could be described as assimilating and comprehending information received. Specific examples of employees who have to provide this type of input could include peer groups of either blue- or white-collar employees who have to undertake, while on the job, a certain amount of task-related reading, or, alternatively, have to listen to an oral presentation by an equipment manufacturer's representative. The white-collar employees could be a group of clerks in the credit department of a large department store; the blue-collar workers could be installers of home swimming pools. Now, the assimilation and comprehension of received information (which is our example of a complex input) - and the linkage between comprehension and productive effectiveness - would obviously be a function of attributes of the individual worker providing this input; but, just as importantly, would be a function in part of what we have called teamness, with networking, it will be recalled, featuring as a key element of teamness. In other words, although comprehension and effectiveness of effort would, as just indicated, depend upon aptitudes of the individual worker, they would also depend upon the worker's interaction with other workers in efforts to understand what is read or acquired in other ways. Notice that here not only the capriciousness of a particular kind of individual ability, but the vagaries of teamness would make the consequences for productive effectiveness of the input in

question (comprehending received information and translating the comprehension into action) a decidedly fuzzy or uncertain (take your choice) matter. Obviously, in these instances the inputs are more complex than what is usually assumed to be supplied in the way of mental-cum-physical effort in conventional models of the theory of the firm or production theory. To move outside the theory of the firm for a moment, consider what, if anything, distinguishes workers from horses in the von Neumann equilibrium-growth model. But, actually, to make this point, there is no need to move outside the (conventional) theory of the firm and theory of production. For not only is there a neglect, in the latter, of the less obtrusive aspects of team production (i.e., teamness et al.), but the question might well be raised, how much difference is there, really, between those uncomplicated, theoretically identical, tangible lumps which are inputs of labour services in the von Neumann equilibrium-growth model and the inputs of labour services in the standard models of the neoclassical theory of the firm and/or theory of production.

10. A Concluding Note

We have admittedly left a trail of unsettled issues and areas of discomfort. In this concluding note, we shall dredge up only one of these. How upset should one become concerning our decision to retain our simplifying assumption of the absence of differences among team members with respect to preferences? "Preference," it will be recalled, was defined by Radner - and it was a definition

we retained - to comprise both tastes and beliefs. So, in our account, preferences are assumed to be executed within the same set of tastes and beliefs across all team members. But _this_ (heroic) assumption still leaves us with the vexing problem of the scope of the logical properties of a team-member's preference relations over alternatives, and especially with the problem of whether or not the team member will in fact be able to discriminate perfectly among the various objects of his/her choice, given the intrusion of those inherently imprecise or fuzzy aspects of team production, including "teamness." Finally, notice that eliminating the simplifying assumption of uniformity of preferences (again, as the latter are defined by Radner) would still leave us with having to face the uncomfortable prospect that the classical "binary logic" of the species, preference/non-preference, may well be inapplicable in the present context.

An Afterword

The hallmark of "meccanno-set" economics is the provision of solutions to _all_ problems, no matter how sticky the latter may be. Fortunately, we trimmed our ambition. Consequently, a meccanno-set structure never emerged.

Footnote

1. Wintrobe and Breton hit upon essentially the same problem with their observations on "the limitation of formal contracts" and the supply of "loosely defined sets of contractual services." (Wintrobe and Breton, 1986, p. 530.)

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