The Efficient Production of External Economies

By MANCUR OLSON, JR. AND RICHARD ZECKHAUSER*

Does independent market adjustment always lead to a less than Pareto optimal supply of goods when there are external economies? The traditional Pigovian conclusion that it did has recently been rejected by some eminent economists. This rejection began with a contribution in this *Review* by James Buchanan and Milton Kafoglis, who produced examples in which independent market adjustment apparently provided optimal or even supra-optimal supplies of goods with external economies, and thus found the orthodox Pigovian conclusion unsatisfactory. Their finding has been accepted by many economists, including William Baumol, who attempted, in a subsequent communication in this journal, to provide a formal, general explanation of their result. This note will show that Buchanan and Kafoglis failed to call attention to the major theoretical point suggested by their examples, and accordingly misinterpreted them. This theoretical point, which is our principal concern, has important implications for economic policy.[1]

The finding that independent market organization of an activity with external economies need not lead to an undersupply of resources for that activity seemed, to Buchanan and Kafoglis, Baumol, and others, to raise grave new doubts about the case for collective intervention in markets with externalities.[2] In fact, it has exactly the opposite implication. This is evident from an understanding of the theoretical point, overlooked in the literature, that different individuals generate external economies with different degrees of efficiency. Independent adjustment in the presence of externalities will generally lead not only to an inefficient level of production, but to an inefficient method of production as well.

A proper understanding of one of Buchanan and Kafoglis' simplest examples will make all of this clear. They consider a hypothetical situation in which immunization for one individual, B, provides an external economy to another individual A, but the relationship is "nonreciprocal," in that immunization for A does not benefit B. Since income effects are ignored, Buchanan and Kafoglis can use marginal evaluation curves as demand curves, and describe the situation with the simple geometric presentation of Figure 1. The valuation individual A places upon protection from contagious disease at the margin is given by demand curve D_A in Figure 1A, and the same is true of B's demand curve D_B in Figure 1B. The marginal cost of shots, represented by the CC lines, is assumed constant and equal for both parties. Individual A, in isolation, would purchase OQ of disease protection, and B, who never

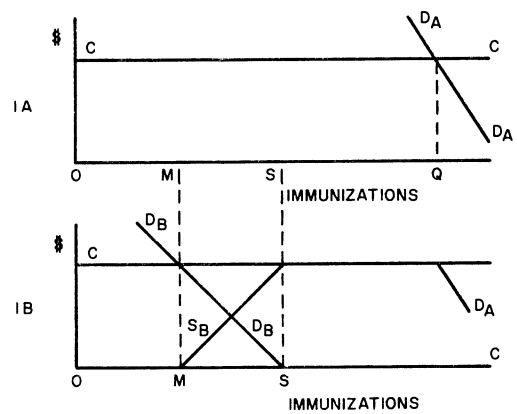

FIGURE 1

* William Baumol, James Buchanan, and Wallace Oates provided most helpful criticisms, but share no responsibility for the faults or conclusions of this note. The authors are, respectively, associate professor at the University of Maryland and assistant professor at Harvard University.

[1] In their 1967 article, the authors discuss the importance of this point and its implications in the context of international alliances for defense.

[2] Buchanan and Kafoglis were not entirely explicit about what they thought the policy implications of their argument were, and might have been misunderstood. See Buchanan and Gordon Tullock, Baumol, and fn. 4 below.

receives any spillover, would purchase OM, whether in isolation or not. When the nonreciprocal externality is taken into account, A's purchase will decline. If B's shots are a perfect substitute for his own, A will reduce his purchase by one unit for every unit that B has obtained. In other words, he will reduce his purchase by an amount equal to OM, and purchase only MQ himself. The combined outlay, $OM+MQ$, is the total equilibrium outlay obtained through independent adjustment.

Buchanan and Kafoglis compare this market equilibrium with the Pareto optimal level of provision. Since each of B's shots does double duty, protecting A as well as himself, both individuals can be made better off by taxing A and using the proceeds to induce B to buy additional shots. The value to A of immunizations of B is given by the marginal cost curve CC until it cuts A's demand curve, and from this point on that demand curve indicates the value to A of additional immunizations for B. By subtracting B's demand curve from the marginal cost curve, we get S_B, B's supply curve of immunization protection for A. The ideal collective outlay is achieved where A's demand curve and B's supply curve intersect; that is, when B obtains OS of immunization and A purchases an additional SQ, for a total of OQ.

In this example, A's intake of shots is reduced by one for every extra shot B can be induced to take. The result is that the total number of shots taken is the same under an ideal (Pareto optimal) collective arrangement as it is under independent market adjustment. If an immunization shot for B were a more-than-perfect substitute for a shot for A, each extra shot B would take under an ideal collective arrangement would make it appropriate to reduce A's outlay by more than one shot, and the collective outlay on immunization would then be *less* than under independent adjustment. Buchanan and Kafoglis therefore draw the general conclusion that independent adjustment can lead to the same outlay, or even to a larger outlay, on a good with external economies than will ideal collectivization.

This example and its implications have been misunderstood. To gain a proper understanding, it is essential to consider the efficiency of the *method* of production of the external economy, and to distinguish it from the familiar question of whether there is an optimal or efficient *level* of production. The externality in the example was nonreciprocal. B's shots give immunity to A as well as himself, but A's shots protect him only. This means—and this is the simple essence of the example—that there are two different production functions or processes that can be used to produce immunity from disease in the example, and that these two productive processes differ in efficiency. If, as in the Buchanan-Kafoglis example, B's shots are a perfect or more-than-perfect substitute for shots for A, and B places a positive value on shots for himself, B is undoubtedly the more efficient producer of immunity. This can be seen in Figure 1, where it is evident that the output of immunity under the ideal collective arrangement ($OQ+OS$) is larger than the output under independent market adjustment ($OQ+OM$), even though the total number of shots taken is equal in the two cases. The reallocation of shots from A to B has increased total immunity.

In general, if there are two or more ways of producing a product and one method is more efficient than the others, it can easily be the case that more will be spent on the good if an inefficient method is used. (If the elasticity of demand for a good is less than unity over the relevant range, increasing the per unit cost of the good to its consumers will increase their expenditure on it, at the same time that it reduces the amount they consume.) Such differences in the efficiency with which external economies are produced explain all of the Buchanan-Kafoglis examples. Whenever one individual is a more efficient producer of an externality or collective good than another, ideal collectivization leads to a greater allocation of inputs to the more efficient producer, and more output per unit of input. The result is that expenditure on inputs may decrease with collectivization, but output increases.

As soon as it is understood that differences in the efficiency with which external economies are generated *entirely* explain the

Buchanan-Kafoglis findings, it becomes clear that Baumol's seemingly rigorous explanation and validation of their result is (though valuable for other purposes) irrelevant to this issue.[3] It also becomes clear that the policy implications have been misinterpreted. The Buchanan-Kafoglis paper leaves the impression that it calls into question ". . . the theory of economic policy upon which arguments for the collectivization of any activity must be based . . ." and the ". . . orthodox policy implication . . ." of that theory (p. 403). In fact, the major policy implication suggested by their examples, which they do not point out anywhere in their paper, is that the shortcomings of independent adjustment in a free market with externalities are greater than has previously been understood. There is now an additional reason for collective intervention when goods have external economies. Independent adjustment through *the market mechanism may not only provide less of the good than is optimal* (*as Pigou told us long ago*), *but will often also make society pay more for the suboptimal supply of the good than it would have had to pay for the larger amount an ideal collective arrangement would provide* (*as we have now discovered*). In other words, it is now clear that independent adjustment in the presence of externalities will lead not only to the production of the wrong amount of a good, but also to an inefficient location or method of production. (There is an exception in the highly special case in which all parties who create external economies provide the spillover at the same cost and are thus equally efficient.) The Pigovian model overlooks the general connection between externalities and the method of production, and is to that extent inadequate, but the traditional conclusion that externalities lead to inefficient market outcomes is now twice blessed.[4]

The practical relevance of this point is evident from a glance at the real-world cases that Buchanan and Kafoglis discuss. They tell us that their interest in this problem arose out of an attempt to explain the fact that, contrary to what the Pigovian model would suggest, expenditures on medical services have expanded more rapidly in the United States than in Britain in the period since the British decided to collectivize medical care. The explanation of this phenomenon that is implicit in their examples is that the production of medical care is, because of nationalization, more efficient in Britain than in the United States, and that the British are getting more health protection than a comparison of expenditures on medical services would suggest. We may personally doubt that this is anything like a satisfactory explanation of an extremely complex phenomenon, but it is certainly the explanation implicit in the Buchanan and Kafoglis argument.[5] Their conjecture that total expenditure on guards, locks, firearms, and other forms of protection might increase if public provision of police services were to cease can be understood in the same way. Private, decentralized provision of police services would presumably be less efficient than public provision, with the result that the society might pay more for police protection and enjoy less.

At first glance, our analysis does not seem to be consistent with Buchanan and Kefoglis' example of reciprocal externalities. In this example, they use a payoff matrix to show the returns to individuals A and B for different numbers of immunization shots for each of them, taking account of the external economies that each provides to the other. In this way they show that *output* as well as *expenditure* on a good with external economies can be greater under independent adjustment than under an ideal collective arrangement. They argued that this result ". . . suggests that, under independent ad-

[3] The reasons why Baumol's argument is off the point, and the true implications of his analysis, are set out in our 1967 article.

[4] Nonetheless, in the real world collectivization may work so badly that the market distorted by externalities would often be the lesser evil.

[5] Elsewhere Buchanan deals with the National Health Service in more detail, and explicitly points to the logical possibility that increases in efficiency could account for the modest size of the increase in British medical expenditures since the National Health Service was established.

justment, the consumption of final output is overextended . . ." (p. 411). How can the logical possibility they have demonstrated by example be explained?

Once again the explanation centers on the differences in efficiency of different ways of generating external economies. It will here be necessary to distinguish between efficiency in the production of a given externality in a total or overall sense, and efficiency in the production of a particular marginal unit. Consider a case in which there are two relevant alternative ways to produce a given external economy or collective good. Method 1 is the manner that results from independent adjustment. Method 2 involves concentrating all of the generation of the collective good in the unit that can produce it at lowest total cost, as would be done under ideal collectivization. Though by assumption total costs of production (at any level of output) are lower using the second rather than the first method of production, it is nevertheless possible that, over some limited range, the *marginal* cost of producing the good is lower if method 1 is employed. This possibility is illustrated in Figure 2, where TC_1 shows the cost of producing the good via method 1 and TC_2 shows the cost under method 2. TC_2, the cost curve for an ideal collective arrangement, lies below TC_1. At point Q_2 marginal value and marginal cost (given by the slopes of the total valuation curve and TC_2) are equal, so OQ_2 is the optimal level of output. Had the less efficient method 1 been employed, however, marginal costs would have been lower over a considerable and relevant range. With TC_1, total gains are greatest at output OQ_1, or at an output greater than the Pareto optimal output. This shows that in certain special circumstances the most advantageous level of output will be larger when a less efficient method of production is used.[6]

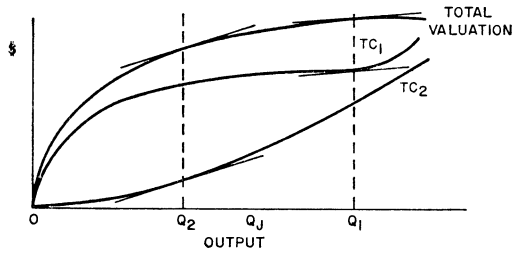

FIGURE 2

Independent adjustment with external economies would not, to be sure, lead to output OQ_1. For the standard Pigovian reasons, each party will ignore the benefits to others of the externality it generates and will produce too little. Independent adjustment will accordingly lead to an output such as OQ_j, which is less than that which maximizes the gain along cost function TC_1, but may well be greater than the Pareto optimal output OQ_2. This shows that it is possible, as in the Buchanan-Kafoglis example, that a larger *output* of an externality would result from independent adjustment than from a Pareto optimal collective arrangement.[7]

[6] Independent adjustment could *not* lead to a larger output than an ideal collectivity, even in these special circumstances, if the ideal collectivity could have produced *every* unit of the externality at a *marginal* cost as low or lower than that confronting any individual member. If the ideal collectivity could have used method 2 to produce all of the units that could have been produced with the least cost by that method, and also used method 1 when its marginal costs were lower (as they are over that portion of TC_1 which is flatter than the corresponding portion of TC_2), then the Buchanan-Kafoglis result in the text would not be possible. This is because the assumption that the collectivity enjoys marginal costs as low at every point as any member obviously insures that its costs of production could not rise faster than under a nonoptimal method of production. The special condition required for the Buchanan-Kafoglis result could, however, clearly be met in practice. This condition would be satisfied if the marginal cost of generating an external economy through a given individual were a function of the number of units *he* (rather than the collectivity) had previously produced.

[7] An examination of the Buchanan-Kafoglis payoff matrix makes clear that their result is in fact explained by our argument. Their Pareto optimal outcome consists in giving 3 shots to B and none to A, but under independent adjustment A and B each get two. When three shots have been given to B, an additional shot brings so little extra immunity it is not worth the cost, whereas when the generally less efficient practice of dividing the shots between the two is followed the fourth shot adds a great deal of immunity (i.e., has lower *marginal* costs in the relevant range).

The payoff matrix in the example also has two maxima. Social welfare functions which allow the result of

The fact that output under independent adjustment can be greater than under ideal collective arrangements does not, however, justify the Buchanan-Kafoglis claim ". . . that, under independent adjustment, the consumption of final output is overextended," even in the special case we have considered. If the inferior production processes used under independent adjustment continue to be used, every one can be made better off by increasing output still further. This is because individuals are not rewarded for the external economies they provide, and accordingly produce too little with any *given* method of production. The output under independent adjustment cannot then be said to be overextended since if it were reduced and no other changes were made, the outcome would be worse for all concerned.

The fundamental concern here is not with the errors and findings in earlier writings, but with the theoretical and policy insights that a proper understanding of this issue allows. The fact that different sources of external economies or collective goods normally generate them with different degrees of efficiency suggests that the production of and "trade" in spillovers should promote productive efficiency by following the principle of comparative advantage. The relatively most efficient producers of a given external economy should "specialize" in that externality, and receive different spillovers or ordinary goods in return. This means that there is some theoretical justification for giving the largest scholarships to the brightest students, for concentrating public health programs on those groups most susceptible to contagious disease, for giving television broadcasting licenses to those stations with the tallest transmitters. In a defense alliance, where each nation's military expenditure provides an external economy to its allies, each member nation could specialize in providing the type of military strength in which it had comparative advantage (e.g. in NATO, the United States could provide missiles, Britain ships, Turkey infantry, etc., as explained in Olson and Zeckhauser, 1967). Those allies whose comparative advantage was not in any type of military capability could reduce their military expenditure and send their allies civilian goods in return for military protection. Similarly, the large city center government in a metropolitan government could provide a large library and a police communications system for the entire metropolis, and the spacious suburbs the land for the airport and the city dump.

Though the literature on this issue has ignored external diseconomies, the argument here also applies to (and has policy implications for) them. When firms producing a good generate external diseconomies, independent adjustment will mean not only that too much of this good is produced, but also that the distribution of output among the firms in the industry, and the nature of efforts to minimize the damage done by the diseconomies, will generally be inefficient. As the analogy with external economies correctly suggests, the firms with the largest external diseconomies per unit of output should restrict output the most, since (other things equal) they can deal with the diseconomy with the least cost. But the emphasis on differences in efficiency in dealing with externalities here calls attention to another possibility; sometimes the most efficient way to limit the damage done by diseconomies is not to limit or change the activity of the offending parties, but rather to have the victims of the diseconomy deal with it. The cost of moving away from or otherwise adjusting to the diseconomies may be less than the costs of preventing or limiting the diseconomy at its source. This in turn means that the commonplace suggestion that those who generate external diseconomies ought to have to compensate their victims for any losses they suffer, can work against Pareto optimality. When such a suggestion is adopted, those injured by the diseconomy

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greater output under independent adjustment will in general have two or more maxima, because there must be a separate local maximum accounting for the greater output under independent adjustment. Welfare functions with multiple maxima and areas where the second order conditions for a maximum are not fulfilled are, as Baumol correctly pointed out, more likely when externalities are present.

have no incentive to protect themselves from it, even if this should be more economical than requiring adjustments on the part of those who generate the diseconomy.

Thus, whether external economies or external diseconomies are at issue, independent market adjustment will in general be inefficient in two distinct ways, only one of which has been properly understood. When there are externalities of either kind, it will not only be true that independent adjustment in a free market will lead to production at a level that is not Pareto optimal, but also that the method of production of the external economy or the effort to combat the external diseconomy will in general be inefficient. In other words, the location of the needed efforts will not be in accord with the principles of comparative advantage. It follows that, contrary to the impression created by the recent literature, what we have is a new idea about how resources should be allocated in the presence of externalities, and an additional argument for collective intervention in markets with externalities. Whether, in view of the often striking shortcoming of collective institutions in the real world, the new argument for intervention should be decisive is another question. But it is surely important that it be understood.

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