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On Cost Pollution and Indirect Externality

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Serie B - Nr. 18

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Serie C: Betriebswirtschaftliche Beiträge (in Vorbereitung)

On Cost Pollution and Indirect Externality

Holger Bonus
Universität Konstanz

Second Draft

May 28, 1981

Externality means that social and private benefit-cost calculations diverge because some fraction of true benefit (or cost) is improperly transferred to third parties. This may take the form that utility functions - or production functions - are improperly affected (technological externality). However, it may also happen that indirect utility functions - or cost functions - are so affected (indirect externality). The resulting distortion in private benefit-cost calculations is every bit as grave as that caused by technological externality. When many parties are involved, a veil of cost pollution is created which poses similar problems as those familiar from environmental pollution.

I.

Externality in its common sense¹⁾ is present whenever one's own utility function is dependent not just upon one's own activities, but upon foreign activities as well. A given activity is labeled "one's own" when it is exclusively under one's own control or authority; and it is "foreign" when it is under the control of someone else.

Thus when you cannot get your daily nap after lunch because your neighbor - that pianist - just won't quit exercising, then some negative externality exists. The same activity is said to generate a positive externality when you wait for him to play, as that makes you sleep so well.

¹⁾ In the definition of externality, we follow the lines of Buchanan and Stubblebine (1962). Thus, "firms" and "production functions" may be substituted for "persons" and "utility functions"; and we are confining ourselves to "technological" externality before introducing its dual, "indirect" externality. The term "externality" as used by Buchanan and Tullock (1962) included both, technological and indirect externality; yet such use was not well received through the mainstream literature concerned with externality. See, e.g., Mishan (1971, p. 6). Our analysis formally reintegrates both aspects of externality.

Suppose you had hired the pianist to do precisely what he did before. Then of course, no externality exists, at least as far as you are concerned. His activity has ceased to invade your own utility function as "foreign", but it is now entered as yours: You are plainly consuming some music that you purchased on the market; and what was inframarginal externality before, now becomes your consumer's surplus. - Or suppose the pianist had received your clearance in advance, by compensating you for enduring the noise. Then you are selling to him on the factor market some of the quietness that you would otherwise enjoy, and receive some factor income in return. The negative externality has then vanished albeit physically nothing has changed. The former inframarginal externality is now called a producer's surplus.

What constitutes externality - marginal or inframarginal, Pareto relevant or irrelevant - is not the fact that foreign activities affect your well-being, as this holds for virtually all activities within modern economies. It is that side effects of foreign activities penetrate your own private sphere in a disorderly manner, overriding any objections as you might have had. When judging the effects of given activities to other parties, we see whether or not they are duly transmitted via contracts among those concerned. If they are, then we speak of normal market transactions, and we acknowledge mutual consent by formally registering the side effects as the receiver's own activity. If they are not, on the other hand, we refuse such acknowledgement and trace the side effects back to their originator, registering them as still his activity. It thus requires some double checking to see whether some given side effect should indeed be classified "external" or not.

Note that we judge the penetration of your own private sphere "disorderly" even when it is perfectly legal. The pianist may have every right to proceed as he cares, and you may still feel uneasy about it. What counts is not the community's consent, but yours.

II.

How about prices? Suppose you had bought yourself some quietness, by bribing the pianist into quitting for a while after lunch. Unfortunately to you, Mr. Jones enters the scene to offer the pianist a well-paid contract; and now the pianist demands a higher bribe which you cannot afford. Then externality is back again, as your privacy is being invaded without your clearance.

If you had hired the pianist to play for you after lunch, and he quits as you cannot afford the high rate he is now charging in view of better opportunities, then we deny the label of "externality" to the new status. True, there is still no contract between the two of you; but then, nothing invades your privacy in a disorderly manner.

In both cases, an element is effective that is sometimes called pecuniary externality²⁾. By offering the pianist an excellent contract, Mr. Jones has disabled you to buy some quietness - or music, as it were³⁾. But the label of "externality" is inadequate here. What happens is simply that you are not prepared to meet the new shadow price which results from Mr. Jones' new taste. Pecuniary externality thus is not "external" at all, but the very instrument by which disorderly appropriation of scarce items is avoided when relative scarcities shift.

Now suppose Mr. Jones and you have both arranged that the pianist will first play for thirty minutes at your place, starting at noon, and thereafter walk two blocks over to Jones' place and play the next thirty minutes there. Yet due to software inadequacy, the bank's computer oddly keeps charging the bank's own expense account, not that of Mr. Jones, whenever the pianist turns in one of Jones' checks, while at the same time your own account is properly charged when your checks are cashed. After a while, Mr. Jones finds that his checks apparently get lost somewhere, and that the pianist's play is in fact costless to him. Quite delighted, he offers the pianist

²⁾Viner (1932)

³⁾As you become unable to bribe the pianist due to his new rate, you suffer "true" externality (the noise), as a consequence of "pecuniary externality".

a two-hour contract; and to get the prime-time right at noon, he pays him a higher rate, too. That hits you real hard. You must settle for a mere fifteen minutes, to be served only when the pianist is through with his two-hour job at Jones' place.

The pianist of course is overjoyed as he does not only get better rates but also more work. Occasionally the bank discovers that general costs are somewhat up, and raises its fees; its customers slightly re-adjust expenditure patterns to make up for the extra cost. As you complain, Mr. Jones advises you that everything is fine, except that you have unfortunately been hit by a so-called pecuniary externality which, however, you should not really view "external" after all. Is he right?

III.

In a way, yes. Jones does command more resources than he used to; and due to the way he got hold of the extra value, he cannot but channel it into the market for pianists, thereby inducing some shortage on that market. The pianist's rate, then, adequately signals such shortage.

And yet, something is quite improper. Mr. Jones never intended to pay himself the additional music he is now demanding. Instead, he simply dumps the cost on all bank customers who must consequently absorb tiny shares of his extra expense, and suffer induced welfare losses. At the same time, economic activities are dislocated: the inflated demand for pianists is matched by expenditure patterns of the bank customers which are no longer socially efficient. Thus we observe the same allocative defects as we would in case of technological externality.

If we see genuine externality as improper exposure to third action, then here is one. Mr. Jones' music consumption draws on the assets of the bank's customers without their consent, inflicting involuntary welfare losses upon them. That in itself does not necessarily constitute genuine externality, as involuntary welfare losses may quite properly arise from shifts in relative scarcities ("pecuniary externality"). Yet the bank's

new fees are not shadow prices reflecting modified scarcity. They are distorted because they contain a surcharge to grant Mr. Jones some free music; and nobody - if only aware of the facts - would be willing to award Jones such a grant. The bank emits false price signals, thereby diverting economic activities from their due course.

While such distortion is transmitted through monetary variables, the generated externality is not of the "pecuniary" variety in the established sense of this term: the involuntary welfare effects that do arise are not due to the functioning of the market; they arise from its malfunctioning. - But such externality is not of the technological variety either, because no physical variables are involved in its transmission. Thus we run into a category of genuine externality that is as yet to be named.

In case of technological externality, the direct utility function is improperly affected; in our example it is the dual, i.e., the indirect utility function, that gets exposed to improper value shocks. To set such externality apart from either pecuniary or technological externality, we propose to name it indirect externality. Note that both, indirect and technological externality, may result in substantial inefficiency, while "pecuniary externality" is indispensable to reestablish efficiency in view of altered scarcities.

As in case of technological externality, it does take some double-checking to see whether a given value shock should indeed be judged "external" - i.e., improperly transmitted -, or not. Again, activities need not be illegal to cause externality. Judged by welfare criteria, Mr. Jones could as well decide to stickup the bank; but happily to him, he needs not go criminal as the bank unwittingly raises the money for him. Jones may even be entitled by law to proceed as he does: Still, the result would be indirect externality. What counts is that Jones induces individuals to pay for him without their own approval; the community's consent (by passing some law) will not suffice to remove externality. What is required to render the income transfers a set of donations, not of external welfare losses, is the consent of those affected, not that of any majority⁴⁾.

⁴⁾ This is, of course, the base of Buchanan's and Tullock's (1962) use of the term "externality".

Thus if Jones steals your money, he imposes indirect externality on you; but if he begs you and you give to him, then no such externality is present. If the government taxes you, then you suffer external welfare losses; but if you subscribe to a government loan, then you do not so suffer. If you cannot afford that Yellowstone trip anymore because gas is in short supply and prices soar, then you are certainly hard-hit, although not through indirect externality; but if you must resign to stay home as the Hunt brothers speculate on gasoline, then indirect externality is with you.

IV.

Technological externality is not that much of a problem when just a few persons are involved⁵⁾; but it gets rough as numbers grow large⁶⁾. The same holds for indirect externality.

When there are just the two of you, Mr. Jones would have to resort to outright robbery to get hold of your money; but that you would probably notice, and resist. Given that many parties are involved, however, Jones is able to draw his extra benefit quietly from the community, by blurring price signals. Prices carry information, and Jones keeps the bank customers disinformed by means of manipulating the bank's fees. In fact, he uses cost pollution as a veil to cover his clandestine manoeuvre: nobody even notices that Jones is extracting money from him.

It is in this unnoticed form that indirect externality will cause real trouble. Suppose that every bank customer - not just Mr. Jones - cheats on everybody else the way Jones does. Then the bank's fees will rise, not just a bit, but quite substantially. Yet neither you, nor any other single customer, will find it rewarding to refrain from cheating: while robbing you of the extra funds, this would do nothing to alleviate the heavy cost burden placed on you as well as on everybody else. The bank's fees then reflect average cheating levels, not just your own level; and given that there are so many parties to the scheme, you cannot influence the average. Thus everybody finds himself trapped within a prisoner's dilemma with no way out, unless everybody turns honest at the same time.

⁵⁾ Coase (1960)

⁶⁾ Buchanan (1965)

The way cost pollution harms all affected parties against their own will is quite similar to what we know from environmental pollution through technological externality. The individual who finds that part of his own activity's true marginal cost is borne by the public, is unable to determine his proper activity levels. Faced with but a fraction of true marginal cost, he will expand his activity to the point where his own marginal willingness to pay equals the fraction that he must pay himself. Since everybody else will do the same, each is consequently hit by the accumulated cost bits dumped on the community through his fellow citizens, all of whom expanded their respective activity levels beyond normal values. In the end, all will overspend on the activity so subsidized (e.g., hiring piano players); and all must then see how to meet ends elsewhere, saving on items they value much higher than the subsidized activity itself.

The institutional setup prerequisite to generate indirect externality is due to computer failure in our example. But obviously, other arrangements may yield the same pattern. As trade unions and big companies agree to raise wages beyond productivity, they dump in fact the resulting extra cost upon the community via price increases, all union members being hit jointly with other consumers; and no single union will see a point in abstaining. Tax evasion means that others are to pay for you; yet if given a chance, everybody will go ahead and evade - only to face stiffer tax rates. Legislators pushing through the House costly measures to help their own constituency, unload the cost on the community; but as other legislators do the same with respect to other constituencies, all that results is growth of public expenditures, and heavier tax burdens. In the ghettos of large cities, part of the trouble is that stealing for a living and burning get so common. With insurance costs soaring, life gets very expensive; yet no one is in a position to quit, as he would still have to meet the stiff insurance cost, but without the benefits of his own robbing and cheating.

Some of the more serious distortions originate from our wish to help the needy. Whenever the government meets hospital bills for low-income families, or whenever it decides to pay tuition for college students, it does so by means of indirect externality. Willing or not, it places the low-income family - or the student - within the position of Mr. Jones, and the community within that of the bank customers. The very same pattern of economic dislocations will hence emerge, notably overspending on the activities so subsidized, - except that those dislocations may become very far-reaching in reality.

V.

For a more formal treatment, consider the case just mentioned, and suppose that marginal costs of some activity (the g -th, say) are to be borne in equal shares by all, because this may appear indicated by social or egalitarian motives⁷⁾. Let \bar{u}^i ($i = 1, \dots, s$) denote the i -th person's indirect utility function, m^i his disposable income (minus saving), and \underline{p} the $(n + 1)$ element price vector, where p_h ($h = 1, \dots, g, \dots, n$) is the price of the h -th commodity and $p_{n+1} \equiv 1$ that of the numéraire:

$$(1) \quad \bar{u}^i = \bar{u}^i(m^i, \underline{p}).$$

Note that $\partial \bar{u}^i / \partial m^i = \lambda^i$ and $\partial \bar{u}^i / \partial p_h = -\lambda^i x_h^i$, where λ^i is the i -th person's marginal utility of income and x_h^i the quantity of the h -th commodity that he demands. Whenever one unit of the g -th commodity is consumed by someone, each person must pay p_g/s , and his disposable income is correspondingly reduced. Thus,

$$(2) \quad \bar{u}^i = \bar{u}^i[m^i(x_g^1, \dots, x_g^s); \underline{p}].$$

Indirect externality is given⁸⁾ by $\partial \bar{u}^i / \partial x_g^j \neq 0$ ($i \neq j$); it is negative when $\partial \bar{u}^i / \partial x_g^j < 0$, and positive when $\partial \bar{u}^i / \partial x_g^j > 0$. The case considered here is, of course, one of negative indirect externality.

From (2) we derive $\partial \bar{u}^i / \partial x_g^i = -\lambda^i (\partial m^i / \partial x_g^i)$ and $\partial \bar{u}^i / \partial x_g^j = \lambda^i (\partial m^i / \partial x_g^j)$ if $i \neq j$, where $\partial m^i / \partial x_g^j < 0$ is the income change that the i -th individual must accept per unit of his own or of somebody else's g -th activity level. In the case considered, $\partial m^i / \partial x_g^i = \partial m^i / \partial x_g^j = -(1/s)p_g$. To eliminate λ^i , we make use of $\partial \bar{u}^i / \partial x_{n+1}^i = \lambda^i$ to form

7) See also the formal derivation of indirect externality within the public-goods framework by Bonus (1980).

8) Strictly speaking, this holds only as long as $\partial \bar{u}^i / \partial x_g^j$ is improper. If the j -th person would pay the full price, a welfare loss caused by rising shadow prices due to added demand from the j -th person would not qualify as indirect externality, but would simply constitute "pecuniary externality".

$$(3) \quad \overset{*}{g}_{ij} \equiv \frac{\partial u^i / \partial x^j}{\partial u^i / \partial x^{n+1}},$$

which simply indicates the i-th person's equilibrium willingness to pay for his own ($\overset{*}{g}_{ii} > 0$) or for somebody else's ($\overset{*}{g}_{ij} < 0$) marginal g-th activity ⁹⁾. Defining the $s \times s$ matrix $\underline{\overset{*}{G}} = [\overset{*}{g}_{ij}]$, we find that in our case

$$(4) \quad \underline{\overset{*}{G}} = \frac{1}{s} p_g \begin{bmatrix} +1 & -1 & \dots & -1 \\ -1 & +1 & \dots & -1 \\ \vdots & \vdots & & \vdots \\ -1 & -1 & \dots & +1 \end{bmatrix},$$

which sharply contrasts to the normal case where everybody pays for himself:

$$(5) \quad \underline{\overset{*}{G}} = p_g \begin{bmatrix} +1 & 0 & \dots & 0 \\ 0 & +1 & \dots & 0 \\ \vdots & \vdots & & \vdots \\ 0 & 0 & \dots & +1 \end{bmatrix}.$$

The off-diagonal terms in $\underline{\overset{*}{G}}$ indicate indirect externality, as evaluated by those affected. The j-th individual appears in the j-th column of $\underline{\overset{*}{G}}$ as the sender of indirect externality, and in its j-th row as a receiver. It is clear that in (4) a serious distortion is exhibited: as the number s of involved persons grows, an overwhelming fraction of true costs is spilled throughout the community by the j-th "sender"; and he will therefore (in all likelihood) grossly overshoot his g-th activity level. But as one can see from the rows of $\underline{\overset{*}{G}}$ in (4), he will at the same time suffer himself a much harder marginal welfare loss from foreign activities than he gains from his own marginal activity; and as a result, overall welfare losses

⁹⁾ In case of positive indirect externality $\overset{*}{g}_{ij} > 0$, while $\overset{*}{g}_{ii}$ is always positive.

will be quite substantial¹⁰⁾. Whoever designed the institutional scheme responsible for this should be aware that his intended benevolency has certainly backfired¹¹⁾.

VI.

We turn to positive indirect externality and choose the monopolist to demonstrate what happens¹²⁾. Stretching our model somewhat, we interpret him to be the s-th person whose only activity consists in producing (and selling) the quantity $x_g^s \equiv X_g = \sum_{i \neq s} x_g^i$. His equilibrium "willingness to pay" is then no longer given by (3), but by the marginal rate of transformation $\frac{F_g^*}{F_{n+1}^*}$ as evaluated within his profit-maximizing point, where it equals his marginal revenue:

$$(6) \quad \frac{F_g^*}{F_{n+1}^*} = p_g (1 - 1/\epsilon_g),$$

with $\epsilon_g = -(\partial X_g / \partial p_g)(p_g / X_g)$ denoting the market demand price elasticity of X_g . Now, the price p_g becomes a function of the monopolist's activity level $x_g^s \equiv X_g$, and the i-th person's indirect utility function reads

$$(7) \quad u^i = u^i [m^i; p_1, \dots, p_g(x_g^s), \dots, p_n].$$

In this notation, price changes as might result from the i-th consumer's own demand (or that of any other single consumer), are neglected because they are "proper", i.e., not due to manipulated scarcity. Resulting welfare shifts would constitute "pecuniary", not indirect externality.

10) One may interpret the quotient of the sum of all off-diagonal terms within one column of \bar{G} , and the diagonal term itself, as a measure of the degree of externality inherent in the j-th person's g-th activity. It is zero in (5) and negative in (4). After some normalization, the quotient is named the "degree of publicness" of the activity by Bonus (1980).

11) The arrangement is not that unrealistic after all. The West German medicare system comes quite close to it; and the cost explosion observed there is not surprising in view of (4).

12) See the point made, and the literature quoted, by Dahlman (1979) in his footnote 4 on p. 142.

Should the effect of the monopolist's own activity level $X_g = x_g^s$ upon the price p_g - and hence upon each consumer's attainable utility level u^i - indeed be judged as improper? We take the position that it should. As indicated by (6), the monopolist realizes his Cournot point. But this requires that the scarcity reflected in p_g is virtual, i.e. induced through the monopolist's output reduction for the very purpose of raising p_g . Thus the monopolist has blurred the shadow price, which is improper¹³⁾. Not unlike Mr. Jones, the monopolist creates a veil of cost pollution in order to draw some extra value from his customers.

But given the Cournot output level, any output expansion would generate positive indirect externality. We derive from (6) and (7) $\partial u^i / \partial x_g^s = \lambda^i (p_g / \epsilon_g) \cdot (x_g^i / X_g)$ for $i \neq s$. Using $\partial u^i / \partial x_{n+1}^i = \lambda^i$, we find that the element of \underline{G}^* in the i -th row and the s -th column is

$$(8) \quad g_{is}^* \equiv \frac{\partial u^i / \partial x_g^s}{\partial u^i / \partial x_{n+1}^i} = \frac{p_g}{\epsilon_g} \cdot \frac{x_g^i}{X_g} \quad (i \neq s).$$

We insert $g_{ss}^* = p_g (1 - 1/\epsilon_g)$ from (6), to obtain the s -th column of \underline{G}^* (written as a row vector for typographical convenience):

$$(9) \quad p_g \left(\frac{1}{\epsilon_g} \cdot \frac{x_g^1}{X_g} \quad \frac{1}{\epsilon_g} \cdot \frac{x_g^2}{X_g} \quad \dots \quad 1 - \frac{1}{\epsilon_g} \right).$$

The off-diagonal terms in (9), i.e., all elements besides the last, are indicating indirect externality. (9) would reduce to

$$(10) \quad p_g (0 \quad 0 \quad \dots \quad 1)$$

if the producer were to sell under conditions of perfect competition; and the indirect externality would then vanish.

In that special case, the producer is prepared to incur marginal costs that eat up the full market price. The monopolist in (9), however, would get far less than such price in return for a marginal output expansion; he would have to settle for just the marginal revenue, which falls short of the full social benefit created through his output expansion. The

¹³⁾ But note that it is not illegal in most cases.

difference p_g/ϵ_g between the social benefit of his output expansion P_g , and the private benefit $p_g(1 - 1/\epsilon_g)$ accruing to the monopolist himself, were to be spread over his customers through external benefits, each customer receiving in proportion to his market share x_g^i/X_g .

And that, of course, is precisely the reason why the monopolist refrains from expanding his output beyond the Cournot level - even though the social benefit of so doing would exceed the social cost. He simply would not be able to catch the full value, as parts thereof would dissipate to his customers as indirect externality¹⁴⁾. Thus while negative indirect externality tends to inflate activity levels beyond Pareto optimal values, positive indirect externality tends to keep them below such values. This property of indirect externality is shared with its dual counterpiece, technological externality.

VII.

Indirect externality is quite as pervasive in real world situations, as is technological externality. It may therefore turn out impossible to determine empirically the size of any given indirect externality, as in fact each pushes us right into second-best situations. Such is the fate of any externality, indirect or technological.

Yet that does not mean, we submit, that the concept of externality is worthless and should be abandoned altogether¹⁵⁾. The indirect externality built into welfare programs and tax schemes, say, results in substantial economic distortions; and any egalitarian policy will run into deep trouble because it cannot but establish new and powerful sources of indirect externality. The inevitable outcome is cost pollution, which is a serious phenomenon worthwhile to be scrutinized. Cost pollution, by obscuring values and misleading economic activities, does have the potential to very seriously disable the invisible hand of the market place.

¹⁴⁾ Lerner's (1933/34) monopoly degree is in fact nothing else but the (indirect) degree of publicness of the monopolist's activity. See footnote 10, and Bonus (1980).

¹⁵⁾ This is proposed, e.g., by Cheung (1970).

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