

An essay on framing and overflowing: economic externalities revisited by sociology

In John Law (1998) On Markets

Michel Callon

When reviewing the conditions required for the existence of markets, no concept is more useful or appropriate than that of 'externality'. The concept of externality is effectively central both to economies and to economics. So an attempt to clarify its significance and scope represents a suitable point of departure for renewed efforts at co-operation between sociologists and economists. Rather than highlighting the limitations and weaknesses of the concept with a view to attacking the limitations and weaknesses of economic theory, I intend to show just how useful it is as a tool for understanding the dynamics of markets, drawing upon sociology as an additional resource.

I shall approach this task from the perspective of the sociologist of science and techniques. This will allow me not only to highlight the role of investment—in particular technological—in the emergence of economic agents that are capable of strategies and calculation; it will also serve as an incentive to take the 'performative' role of the sciences—and hence also of economics and sociology—more seriously.

I shall start by putting my economist's hat on in order briefly to remind my fellow sociologists of the various ways in which the concept of externality can be defined, together with its practical and theoretical implications. This will lead on to a discussion of the various mechanisms upon which the concept is predicated. I shall then touch first upon what I shall here refer to as 'framing/overflowing' and upon the various issues associated with the identification, measuring and containment of such overflows. I shall subsequently focus my attention on the role played by the technosciences in the proliferation of overflows, highlighting the active role of the social sciences—alongside the natural sciences—in the identification and management of externalities. Finally, I shall draw one of the most important conclusions suggested by this exercise: that the market is not simply expanding, but rather continuously emerging and reemerging, and that its consolidation requires constant and substantial investments.

1. Definition(s) and issues

1.1. Definitions

Since this text is intended as much for sociologists as for economists, I shall start by spending a little time defining the concept of externality, since many sociologists are currently unfamiliar with it.

The simplest approach is to start with an example. A metallurgical factory produces aluminium and emits chlorinated fumes. These spread out over the countryside, representing a threat to neighbouring livestock and crop farmers. In order to combat or eliminate the noxious or toxic effects of these fumes (which cause weight loss in livestock and reduce crop yields), the affected farmers must make certain investments. It is here that the concept of externality becomes pertinent, in the sense that in the absence of any incentives to do so, the chemical company fails to account in its calculations for the costs that it is imposing upon agents (in this case, the neighbouring farmers) who, despite the fact that they are penalized by its activities, remain external to the sphere of economic relationships in which the company itself operates. This failure gives rise to externalities—in this case negative. The farmers' interests are compromised and they are unable to assert their own preferences since, in order to remain

commercially viable, they must make investments for which they can not negotiate any compensation.

But externalities can also be **positive**. Consider the example of a pharmaceutical company with research and development (R&D) laboratories that use screening methods to test large numbers of molecules prior to undertaking clinical tests once the various active substances have been identified. To protect its findings and the potential profits it can expect from related monopolies, the company files patents which disclose some of the information that has been produced. The latter thus becomes available to competitors and may inspire them to rethink the direction of their own research. Such transpositions are all the more straightforward and productive because they are predicated upon very similar knowledge bases (Richardson, 1972). Competitors may thus benefit, free of charge, from the efforts and investments of a company which has had to bear the associated costs and risks on its own. This case is a classic example of 'positive externalities', the mirror image of the preceding kind. It is easy enough to show that such situations are commonplace wherever business activities result in the production of information with the potential for large-scale application.

It appears that the concept could be extended to include behaviour which is not exclusively economic in nature. Take the case of a teenager living in a terraced house who decides to arrange a birthday party. The celebrations go on late into the night. Driven by a heady mix of booze and bopping, the volume of the music steadily increases. Unfortunately he did not invite his neighbours to the party. If we imagine that there is no legislation banning such late-night festivities, the situation becomes comparable to that of the factory polluting the surrounding environment. The person holding the party maximizes his own well-being, but only to the detriment of his neighbours, who have no legal means of eliminating the source of the nuisance and so must devote a portion of their resources, time and energy to combatting the noise. Effects of this kind are not necessarily negative in themselves. If my house is off the beaten track and my neighbour decides to build a service road, my well-being is improved without any related expenditure on my part. If, like me, my neighbour enjoys French Baroque music and plays it loudly enough for me to hear every note clearly, my well-being is enhanced despite the fact that I have not had to make any investment myself.

The analysis could be extended still further. The applicability of such a generalization is clearly demonstrated by the now classic sociological issues underlying the systematic negation of the investment and work required to create a situation which subsequently appears to be an entirely natural 'given'. In this case, certain agents pursue courses of action the costs of which are borne by other agents, with no visible transfer taking place.' The concept is strikingly expressed by the American feminist slogan of the '70s: 'Behind every successful man is an exhausted woman'.

I won't discuss such wider applications of the concept of externality, which poses the now classic question of how best to extend economic categories (such as cost, preference or interest) to cover all human activity. I shall restrict the discussion to an issue that is more specific, more technical and also more interesting: namely the indirect (ie, non-commercial) effects of commercial activities unfolding within a framework of market relationships.

The preceding examples and the restriction that I have just imposed on this discussion suggest the following definition of the concept of externality:

Let A, B, C etc. be agents involved in a commercial transaction, or more generally in the negotiation of a contract. In the course of the transaction or contract negotiation, these agents

express their preferences or interests and then evaluate the various possible decisions arising from them. The decision they finally take has positive or negative effects, here referred to as externalities, on another set of agents X, Y and Z (as distinct from A, B, and C; the latter are not involved in this transaction or negotiation, either because they have no way of intervening or because they have no wish to do so).

1.2. Issues at stake

In itself, the existence of externalities is not in the least outrageous. That certain people should pay for others or profit from others without bearing the associated costs is not disgusting or disturbing. Such transfers are inevitable: after all, the laws of thermodynamics teach us that you cannot have order without paying the price of chaos. So it is not on moral grounds, but on the grounds of collective efficiency and the optimization of resource allocation that the existence of externalities and various possible ways of eliminating them preoccupy economists to such an extent.

In economics, the concept of externality is linked to a more general category: that of market failures.² At this point, it is important to obviate any misunderstandings. The term ‘market failure’ does not mean that nothing good was produced. Its meaning is more precise: as expressed in terms of efficiency or in terms of the provision of socially desirable goods, the best result that could have been obtained was not achieved in practice.

So what are the consequences of externalities in terms of the role played by the market and prices in the allocation of resources? Within the framework of economic doctrine, the answer to this question is simple. Externalities, whether positive or negative, render the market (at least partially) inefficient, because they are responsible for a gap between private marginal income and marginal social costs. The previous sentence might seem obscure to a non-economist. But the argument is easy to understand. Take the factory mentioned earlier, belching out chlorinated fumes that pollute the surrounding countryside. According to the hypotheses of standard economic theory on this subject, the factory will set the volume of its aluminium production in such a way as to ensure that its marginal income (ie, income corresponding to the last ton or other unit of aluminium sold) is equal to the additional cost incurred in producing this extra ton or unit. According to a number of hypotheses—space, alas, prevents us from discussing them here—economic theory shows that the equilibrium, resulting from the equalization of marginal costs and income, is an optimal one. But if externalities are present, this private calculation, which is supposed automatically to guarantee a social optimum, is biased: it does not take into account the investments which the farmers must make in order to protect themselves from the fumes. In this case, in the absence of appropriate incentives, the market—as a device for obtaining the social optimum—is deficient. This reasoning applies equally to what are known as ‘positive’ externalities: a medical pharmaceutical company can sit back and wait for its competitors to invest in R&D in the expectation of profiting from the results without spending anything at all. In their anxiety to prevent others from taking advantage of them, players in the sector avoid committing resources, and this in turn means that the collective welfare is substantially lower than it could be if appropriate investment incentives were in place. Negative externalities imply social costs that are not taken into account by private decision-makers; positive externalities discourage private investment by socializing the benefits.

The definition of externalities seems to be clear. In reality, it raises a series of questions which I now propose to examine in more detail, and which will allow me to outline the terms of a new contract of cooperation between economics and constructivist sociology

2. Framing and overflowing

Beneath the concept of externality lies the more fundamental concept of framing, which implies the possibility of identifying overflows and containing them. Economists do not use this concept, which I am borrowing from Goffman for the purposes of this argument. Once I have reminded my readers of its significance I will emphasize, along with constructivist sociology, the size of the investments required to frame interactions and contain overflows.

2. 1. Framing interactions

In his description of interpersonal relationships (of which the relationships involved in arranging the negotiation of a contract represent one archetype), Goffman resorts to the concept of the frame (Goffman, 1971). The frame establishes a boundary within which interactions—the significance and content of which are self-evident to the protagonists—take place more or less independently of their surrounding context. Goffman emphasizes the dual nature of this framing process. Clearly it presupposes actors who are bringing to bear cognitive resources as well as forms of behaviour and strategies which have been shaped and structured by previous experience: the actors are capable of agreeing (an agreement which does not have to be explicit) on the frame within which their interactions will take place and on the courses of action open to them. But the framing process does not just depend on this commitment by the actors themselves; it is rooted in the outside world, in various physical and organizational devices. This is why framing puts the outside world in brackets, as it were, but does not actually abolish all links with it.

In order to illustrate this definition, Goffman—who loves theatrical metaphors—frequently takes the example of a stage performance. Given the series of interconnected expectations upon which such performances are predicated, they could not take place without the tacit agreement of all those taking part. The spectators know what ‘watching a theatrical production’ entails and what rules they should obey (so for example they know that as the curtain falls in preparation for the next act, they may break the silence by coughing or clearing their throats). In the same way, the actors on stage know what is expected of them, as do the usherettes and cashiers. But these tacit agreements would swiftly fall apart if they were not contained within a suitable physical framework. A whole series of material means are used to demarcate the theatrical space and the actions that take place within it: the building itself, its internal architecture; the bell, dimmed lights and raising of the curtain that indicate the start of the performance. Similarly, the end of the performance is framed by a series of devices linked in such a way as to make the uncertain spectator aware that this is ‘THE END’ rather than just another interval. The various elements that form the physical frame are themselves contained within an institutional framework (author’s rights, safety regulations, tax incentives etc.) which helps to ensure their preservation and reproduction.

This ‘bracketing’, which assumes that boundaries are drawn between the actors interacting with one another on the one hand and the rest of the world on the other, does not imply a total absence of relationships. On the contrary: for Goffman, framing would be inexplicable if there was not a network of connections with the outside world: ‘We cannot say the worlds are created one spot because, whether we refer to a game of cards or to teamwork during surgery, use is usually made of traditional equipment having a social history of its own in the wider

society and a wide consensus of understanding regarding the meanings that are to be generated from it', (Goffman, 1961). Goffman thus emphasizes the fact that everything mobilized in the framed setting guarantees, simply by virtue of its presence, that the outside world is also present. The concept of habitus proposed by Elias and Bourdieu is clearly one way of describing this link and the manner in which it is expressed in the course of the action, but Goffman suggests that over and above the human beings themselves and their disciplined bodies, objects and things, the theatre stage, its walls and sounds, all play a role in setting up these interdependencies.³

This concept of framing is easily applied to the interactions that interest economists, whether in the form of classic commercial transactions or contract negotiations. To negotiate a contract or perform a commercial transaction effectively presupposes a framing of the action without which it would be impossible to reach an agreement, in the same way that in order to play a game of chess, two players must agree to submit to the rules and sit down at a chessboard which physically circumscribes the world within which the action will take place.

It is possible to respond to this concept of framing, which is essential to any understanding and description of interactions of whatever kind, by adopting one of two diametrically opposed attitudes which I will now examine in turn. Each of them gives preference to one of the two dimensions of framing, either by emphasizing the closure of the interactions on themselves and the role of the players' mutual agreement in creating this closed situation or, conversely, by highlighting the omnipresence of connections with the outside world and the irrepressible and productive overflows which the latter encourage.

2.2. When framing is the norm and overflows are leaks

The first approach tends to believe that framing is the norm—in the double sense of something that is desirable and also statistically predominant—and that overflows are exceptions which must be contained and channelled with the help of appropriate investments.

This position is adopted by micro-sociology, which focuses on interpersonal relationships without considering the factors that sustain these interactions.⁴ It is also popular in economic theory, where one of the central preoccupations is to postulate the existence of configurations within which a series of agents develop (commercial) relationships with each other that are sufficient in themselves to account for all co-ordination requirements. The concept of framing indicates that such closure is possible: individuals, whether two or 2,000 in number, whether by communicating through prices or taking turns to negotiate contracts, together regulate problems of resource allocation or property transfer while simultaneously establishing a temporarily impenetrable barrier between themselves and the rest of the world. In this way, any two agents can undertake—in an agreement that depends solely on the exercise of their wills—to interact in a negotiation and then return to anonymity once the transaction is complete. This effectively postulates the actual possibility that a market could exist as a system of relationships between agents (consumers and producers) who reach an equilibrium or harmonious accord. Framing defines the effectiveness of the market because, in this closed interactional space, each individual can take into account the viewpoint of every other individual when reaching a decision. In this sense, it is possible to assert that externalities are simply the results of imperfections or failures in the framing process. Yet in certain cases framing is either impossible to achieve or is deliberately transgressed by the actors:⁵ this produces overflows which cause the barriers to become permeable. Economic theory seems predisposed to the hypothesis that these overflows should be regarded as accidental and

consequently that framing should be perceived as the norm towards which everything should tend.

By prioritizing the creation of frames designed to avoid premature overflows, economists are obliged to focus much of their attention on the various forms of overflow that can take place and how best to contain them; ie, on all the repercussions of the contracts linking A, B and C on those not involved in the negotiations (X, Y and Z). This has two consequences. The first is to cause economists to focus their efforts—with evident success—on the identification of leaks and the formulation of devices for creating more effective frames.⁶ The second is to facilitate, in certain typical situations, the establishment of tried-and-tested frames: as recently shown by DHL's decision to set up its European hub in Strasbourg, the harmful effects associated with the presence of an airport are no longer simply accounted for after the event; they are brought into the frame in the initial stages of contract negotiation.

2.3. Overflows are the norm: framing is expensive and always imperfect

The second attitude, typical of constructivist sociology in particular, takes the view that overflowing is the rule; that framing—when present at all—is a rare and expensive outcome; in short, is very costly to set up. Without the theatre building and its physical devices; without years of training and hours of rehearsal put in by the actors; without the habitual mindset of the audience and carefully written dramas which deliberately limit the range of preprogrammed interactions, the framing of a stage performance would be quite simply inconceivable. This viewpoint is thus the exact opposite of the preceding one: instead of regarding framing as something that happens of itself, and overflows as a kind of accident which must be put right, overflows are the rule and framing is a fragile, artificial result based upon substantial investments.⁷ Constructivist sociology does not deny that it is possible to achieve such clarity or put such frameworks in place, nor that such an objective is worth pursuing (see below for a more detailed discussion of this point). But it is primarily interested in showing that such a framing process, in addition to requiring expensive physical and symbolic devices, is always incomplete and that without this incompleteness would in fact be wholly ineffectual.

Let us start by considering the concept of embeddedness first put forward by Polanyi (Polanyi, 1975) and subsequently taken up by Granovetter (Granovetter, 1985). This does not so much represent yet another expression of the implacable hostility between sociology and economics⁸ as an affirmation of the omnipresence of overflows. E. Friedberg rightly highlights the habitual misinterpretation of this concept (Friedberg, 1993). Its significance, which is both profound and radical (and incidentally the main theme of Granovetter's celebrated article) centres on the hypothesis that the objectives, intentions, interests and projects of a given actor, and indeed his or her will, are not simply a set of attributes that define his or her own personal, unchangeable identity which the actor could simply by intellectual application, access or express—even unconsciously—if she or he were given the opportunity (this being the meaning of the expression 'to reveal one's preferences'). Nor are they the result of values, norms or institutions which reduce the actor to the status of the 'cultural dope' so justifiably ridiculed by Garfinkel. In fact, they cannot be dissociated from the network of interdependencies in which the actor is enmeshed and to which he or she is continuously contributing (Burt, 1992), (Callon and Law, 1997). In short, the actor's ontology is variable: his or her objectives, interests, will and thus identity are caught up in a process of continual reconfiguration, a process that is intimately related to the constant reconfiguration of the network of interactions in which he or she is involved.

From this perspective, all framing thus represents a violent effort to extricate the agents concerned from this network of interactions and push them onto a clearly demarcated ‘stage’ which has been specially prepared and fitted out. But their links with the ‘outside’ world - links that betray their existence simply by the fact that the agents are simultaneously involved in other worlds from which they can never be wholly detached—cannot be reduced to personal relationships alone.’ Overflows have many sources and can flow in many directions, which tends to indicate that frames are even more problematic than Granovetter suggests.

Take the example of a research contract drawn up between an academic research unit and a commercial enterprise, nowadays a commonplace occurrence. Such a contract does not bind one human being to another, but one legal entity to another legal entity. Each of them is a more or less integrated complex comprised of human beings, equipment (instruments, machinery), libraries and financial resources. The contract provides for the performance of certain actions, defines the terms under which any property rights arising from the results of these actions will be shared, and defines the conditions for monitoring the proper performance of the contract. The text of the contract sets out the joint venture’s objectives. The definition of these objectives is frequently—but not exclusively—couched in terms of concepts and ideas borrowed from accepted scientific theory (for example: ‘the work shall contribute to the development of an enzymatic electrode capable of functioning in aqueous media’ (Cassier, 1995)); it also implies the application and/or possible development of experimental tools or procedures which are mentioned or described in a wealth of technical detail; it generally includes the name(s) of the researcher(s) or research team(s) who will be in charge of the research programme. The contractual undertakings may be more or less specific or complete; clearly all this is dependent on the degree of stability and predictability of the relevant area of research. Clauses providing for the renegotiation of the contract if certain events should take place may also be appended. In short, the aim of the contract is to frame the interaction in as unambiguous a way as possible and/or formulate an agreement on any rearming procedures which may have to be implemented.

But what are the conditions governing the stability (or lack of it) of a contract—or rather, of the framing process that it applies by defining a limited number of actions to be undertaken in an infinite world of possible relationships? As many have remarked since Durkheim, the framing of a contract presupposes the existence of courts of law, as well as the existence of a body of legal texts defining, for example, the content and scope of property rights, as well as the existence of solicitors entrusted with recording the state of knowledge held by each of the contracting parties before the contract comes into force, and so on. But—and this is more interesting for our purposes—such general devices, all of which have a cost, in fact only play a peripheral role, as Williamson clearly perceived. The actual text of the contract introduces a series of tangible and intangible elements (concepts, materials, substances, experimental devices, researchers etc.) which help to delineate and structure the frame within which it will be performed. The contract could not be framed and ‘fulfilled’ without the participation or requisition of each of these elements: they are involved in the same plot, the same scenario; each of them is obliged to play a predefined role. The actions within the frame are prepared and structured by the equipment, the theoretical statements, the skilled persons of the researchers and technicians, the procedures and reports; all these elements ensure that they are not scattered or dispersed. But—and here we come to the crux of the argument—each of these elements, at the very same time as it is helping to structure and frame the interaction of which it more or less forms the substance, is simultaneously a potential conduit for overflows. The researchers interact with colleagues, take part in conferences, may move temporarily or

permanently to different companies or research laboratories. Scientific ideas and concepts circulate on the Internet or through the intermediary of scientific journals, becoming the subject matter for debates and controversies which refine their meaning both within the group and outside it. If theories did not have a public life, they would not exist as certified knowledge. As for the instruments, materials or substances: they are calibrated, standardized and exist in various locations; the way they are modified or perform in one location may have direct repercussions on their performance in other locations.

The different elements constituting the research programme and by extension the research contract are simultaneously resources and intermediaries (Callon, 1991); they frame the interactions and represent openings onto wider networks, to which they give access. It is this dual nature that guarantees the productivity of the entire complex represented by the programme which thus becomes capable of capitalizing to some extent on what is being done elsewhere, on what has been done in the past and on what will be done in the future. No contract is capable of, or has an interest in, systematically suppressing all connections, burning all bridges or eliminating the dual nature of every element involved. Which is why the heterogeneous elements, that are linked together in order to frame the contract and its performance, in reality take part in its overflowing: and it is precisely because they are sources of overflows that they make the contract productive. This can be expressed in terms of a paradox: a totally successful frame would condemn the contract to the sterile reiteration of existing knowledge.¹⁰ It is therefore illusory to suppose that one can internalize every externality by drawing up an all-embracing contract that provides for every eventuality, just as it would be erroneous to equate the incompleteness of the frame with the incompleteness of the contract: the potential sources of overflow are to be found in precisely those elements that give it its solidity, rather than in any areas left unmentioned.

To recap: (I) framing is costly because overflows happen all the time, since they are fed by multiple sources and flow down multiple channels. Framing cannot be achieved by contractual incentives alone, because it is bound up with the equipment, objects and specialists involved in the interaction: it is they who, in their stubborn and obstinate way—to paraphrase a suggestive remark by Whitehead—ensure that certain courses of action are followed and at the same time generate externalities; (ii) this costly framing process is necessarily incomplete: first because a wholly hermetic frame is a contradiction in terms, and second because flows are always bidirectional, overflows simply being the inevitable corollary of the requisite links with the surrounding environment. Without overflows, it would not be feasible to add value locally; thus the only way to stamp out ‘reverse engineering’ would be to bring all industrial and commercial activity to a standstill! It is because an actor’s output gets necessarily beyond her entire control so as to generate profits, that the actor him- or herself is unable to avoid externalities. “

3. In order to be framed, overflows must be made measurable

In a recent article, Williamson defines the economic approach as follows: ‘Calculativeness is the general condition that I associate with the economic approach and with the Progressive extension of economics into the related social sciences’ (Williamson, 1993). Without calculative agents and without the minimum level of information that allows such calculations to take place, market coordination is bound to fail. This is why economists—and it is one of their great virtues—demonstrate such an obstinate desire to define the conditions in which actions become calculable, and to think up devices that will encourage such conditions to emerge. It is by allowing each agent to have preferences, to hierarchize them, and then to

reveal and negotiate them—in a word, to calculate his or her interests, express them and defend them—that transactions are allowed to take place, resulting in a robust and legitimate, if not necessarily, optimal re-allocation of resources and property rights. It is at precisely this point that sociology can make its contribution. By focussing on the omnipresence of overflows, on their usefulness, but also on the cost of actions intended (partially) to contain them, constructivist sociology highlights the importance of the operations required to identify and measure these overflows. It also encourages us to question the mechanisms used to create frames by suggesting ways in which the social sciences might help to develop or to confine such spaces of calculability.

3.1. Identifying and measuring

The very definition of externalities (see 1. 1 above) implies that it is possible to identify not only actors A, B and C but also the effects produced by their activities. Only once this double identification has taken place is it possible to draw up a list of age who benefit or suffer from these externalities (X, Y and Z).

These processes are often regarded as self-evident and self-explanatory. That this is not in fact the case is clearly shown by the controversies surrounding the reality of the existence of externalities. Three problems arise:

(I) The first is how to identify the effects, ie, how to prove the reality of the overflow. The latter—and this is a point that sociologists will take pleasure in highlighting—cannot be intangible. For something to happen that affects agents outside the frame, it is essential that something should cross or break through the boundary drawn up round the commercial interactions within the frame. Let us call these entities that secretly cross the frame's boundaries intermediaries: they may be chemical substances, sound waves rippling outwards, texts, scientific articles, patents, or researchers or engineers on secondment or moving to other institutions. No externality can exist without relationships; no link can exist unless it follows a trajectory plotted by a material object acting as the medium for the externality. The existence of the latter is predicated upon this simple but unavoidable quality of tangibility: for an overflow to take place, something must overflow. But identifying the actual intermediaries is anything but straightforward.

Some of them, by their very nature, are difficult to identify; others, like spy planes, are deliberately camouflaged by those who send or receive them. Between industrial espionage at one extreme and the publication of patents at the other, for example, there is an entire gamut of intermediate practices which are more or less easy to track down; between the colourful pollutant that indicates the presence of a leak and the odourless, colourless fumes that baffle the most vigilant observer, there is a wide variety of effluents that are more or less easy to identify. In short, with very few exceptions, specific work must be done in order to provide incontrovertible proof of the simple existence of an overflow or leak, implying at the very least the implementation of monitoring procedures and sensors.

Like the natural sciences, the social sciences are obviously involved in these devices, which without them could not exist. When a sociologist demonstrates that hauliers are effectively relying on car drivers to subsidize the cost of their business activities, he is taking part in the process of designing and implementing such sensors. When an economist formulates methods of calculation and constructs proxies designed to test for the existence of technological spillovers (another term for overflows) from one industrial sector to another, he is contributing to this endless tracking process. The aim of the process is to map, as realistically

as possible, the trajectories of the various intermediaries which are constantly escaping from the interactional frames that gave birth to them and scattering down a multiplicity of unpredictable pathways. Similarly, a chemist taking and analysing water or atmospheric samples is participating in this immense work of identification; occasionally it turns into a real-life police inquiry, as in the infamous case of the Seveso barrels.

(ii) Providing proof of the tangible existence of overflows is inextricably linked to the identification of their sources and impacts. It is not enough to demonstrate the reality and consistency of overflows; it is also necessary to establish who is responsible for them and who is affected by them. Once again, the effort required is often immense. Various environmental issues provide dramatic evidence of this. It is quite possible to uncover trafficking in toxic waste between Germany and France without necessarily being able to trace the channel back to its source. In some cases, establishing the nature and tangible existence of the effects of overflows presupposes ever-increasing levels of investment. Are CFCs really responsible for the hole in the ozone layer? What are the consequences of global warming, for whom? Does asbestos cause damage to health? Can prions from mad cows be transmitted to human beings and if so, are they communicated through animal feed? Above what levels of atmospheric concentration of dioxin do the lesions caused in cells become irreversible?

In order to draw up these two lists—the list of sources (A, B and C in our earlier definition) and the list of targets (X, Y and Z)—specific studies must be undertaken, sometimes obliging us to create appropriate instruments. The situation is further complicated by the fact that the agents concerned may very well not possess an individual existence or identity until such time as the overflows have been confirmed. In this case, the identity of the group and the awareness of its members that they form a part of it are the outcome of the process of discovering and highlighting the externalities. Riverside farmers in the polluted Loue region; pregnant women under 30 who were prescribed thalidomide; manufacturers of luxury goods who export their products to South-East Asia only to become the ‘victims’ of counterfeiters: none of them existed as clearly defined groups with interests to defend and a voice to make themselves heard until researchers had succeeded in proving—albeit in ways that are always open to contention—the reality and nature of the overflows involved. There are many other examples of the kind of investigative effort required—involving experts and counter-experts, measuring instruments and diagnostics—in order to arrive at an acceptable description of the externalities and agents involved.

The devices that allow us to visualize the existence of the externalities play a crucial role in this descriptive process. They play a potent part in the formation of the groups concerned and in the growth of their self-awareness: when Parisians read in their daily newspapers that the pollution index has risen above the danger level, or illuminated signs inform the citizens of Florence that ozone concentrations are above the critical threshold, they find it easy to experience themselves either as the victims of motor traffic or conversely, as the drivers responsible for environmental pollution. This real-life experience—sometimes referred to as subjectivity—is largely dependent on the instruments used to identify overflows.

(iii) From the perspective of economic theory, it is not enough to record—those familiar with debates within the social sciences unrelated to economics will have gathered that I would prefer to say: perform—these externalities. Overflows are devoid of economic significance unless they give rise to evaluations and measurements. The theory of externalities requires a metrological framework—ie, measuring instruments—that allows the different agents to

negotiate an agreement by calculating their respective interests. The possibility and viability of this negotiation both depend on the availability of instruments capable of producing incontrovertible measurements: clearly no negotiation can sidestep the need to respond to issues concerning the extent and scope of the overflows in question. For the farmer working alongside the polluting factory to be able to define his interests and quantify the impact of the overflows on the efficiency of his operation, he must have recourse to legitimate, recognized measuring instruments.

Without calibrated sensors, without epidemiological studies, no negotiation is possible. Agents are unable to establish the cause of their problems or benefits, or the extent of their losses or gains; so it is clear that no compromise can be reached in the absence of such a metrological structure. This is another point at which the natural and social sciences can make a contribution. The chemist who perfects an instrument which is officially approved and can be moved from one place to another without detriment to its performance is providing 'objective' data, usually quantifiable, which allows the agents to measure the externalities and enter into rational negotiation (Mallard, 1996b).¹² The econometrician who uses patent statistics to measure the overflow from one sector to another is clearly taking part in such an exercise, as is the psychosociologist who uses psychometric scales to rank personality disorders that may be due to the sufferers' social environments or the potentially detrimental actions of certain agents.

Once the overflows, source agents and target agents have all been correctly identified and described, and once measuring instruments for quantifying and comparing them have been set up, it becomes possible to reframe the interactions. At this point it is meaningful to assert that X, Y and Z should be allowed to participate in negotiations concerning contracts between A, B and C from which they were formerly excluded. This is the tangible result of the investments we have just described in all their scope and diversity: to give the option of internalizing the externalities, or to put it another way, of rearming hitherto uncontained overflows. These investments apply and produce both knowledge, in that they cause hitherto invisible links to appear, and also a reconfigured collective in which these now visible and calculable links have been renegotiated. The social sciences contribute to this dynamic.

3.2. Tracing the mechanisms by which controversial situations—where overflowing is the rule—become calculable, in other words capable of being framed

For calculative agents to be able to calculate the decisions they take, they must at the very least be able to a) draw up a list of possible world states; b) hierarchize and rank these world states; c) identify and describe the actions required to produce each of the possible world states. Once these actions have become calculable, transactions and negotiations can take place between the different agents. In the light of the discussion in the preceding section, I shall now concentrate on the role of the technosciences in the dynamics of overflows and on the possible contributions that could be made by sociology and economics respectively towards framing them and making them calculable.

(I) In 'hot' situations, everything becomes controversial: the identification of intermediaries and overflows, the distribution of source and target agents, the way effects are measured. These controversies, which indicate the absence of a stabilized knowledge base, usually involve a wide variety of actors. The actual list of actors, as well as their identities, will fluctuate in the course of the controversy itself, and they will put forward mutually incompatible descriptions of future world states.

A. Rip and myself have suggested that these highly confused situations should be given the name of ‘hybrid forums’, because facts and values have become entangled to such an extent that it is no longer possible to distinguish between two successive stages: first, the production and dissemination of information or knowledge, and second, the decision-making process itself. Such forums have been proliferating ever since the emergence of the controversy over the hole in the ozone layer in 1974. The crisis relating to mad cow disease is a classic example: here, the turmoil has reached its apogee, foreshadowing situations which will probably become very common in the near future. This hybrid forum is overflowing continuously, with an ever-growing, ever-more-varied cast of characters beside which Leporello’s *catalogo* pales into insignificance. By turns we hear from vets, farmers, manufacturers of animal feed, proponents of Thatcherite deregulation, Cordelia (daughter of the British agricultural minister, who appeared on television with her father, eating a beef-burger with evident enjoyment), Brussels, the British government denouncing protectionism, the Germans (accused in passing of ‘perfidy’ by the British), outraged members of the public, the media, prions (or rather the biologists studying them), butchers frantically acquiring every quality certificate going, politicians losing their heads. The controversy lurches first one way, then the other—because nothing is certain, neither the knowledge base nor the methods of measurement. Not only are the various actors and their interests in constant fluctuation, but even when they enter the debate they are incapable of reaching agreement either on the facts or on the decisions that should be taken. Framing—predicated upon the assumption that actions and their effects are known and measured—is a chaotic process, the implementation and control of which depend directly on the evolution of the controversies involved and on the construction of an agreement regarding the reality and scope of the overflows.

(ii) In ‘cold’ situations, on the other hand, agreement regarding ongoing overflows is swiftly achieved. Actors are identified, interests are stabilized, preferences can be expressed, responsibilities are acknowledged and accepted. The possible world states are already known or easy to identify: calculated decisions can be taken. The sudden but nevertheless foreseeable—because already experienced pollution of a watercourse by a chemical factory falls into this category: sensors are already calibrated, analytical procedures are codified; the protagonists already know how to calculate their costs and benefits and are ready to negotiate (if necessary on the basis of clearly formulated insurance contracts) in order to determine the level of compensation payable.

(iii) ‘Hot’ and ‘cold’ situations have co-existed ever since the sciences and technology first rose to pre-eminence in Western culture. But the ‘hot’ source of this mysterious Carnot’ cycle is becoming increasingly invasive and omnipresent, for at least two reasons:

- The first relates to the growing complexity of industrialized societies, a level of sophistication due in large part to the movements of the technosciences, which are causing connections and interdependencies to proliferate. Here again, the crisis over mad cow disease has a symbolic value. The current situation is the result of the intertwining of a whole series of decisions and interrelated actions, initially autonomous but gradually weaving a web over time that is proving very difficult to pick apart in retrospect, so numerous and heterogeneous are the elements bound up within it.

A regulatory decision (to stop imposing a minimum temperature for the preparation of animal feeds) results following a complex but initially unsuspected—because unheard-of—interplay of interdependencies, in the possible infection of human brains. Within this labyrinth of unexpected and rapidly proliferating connections, establishing the facts (can prions infect

human beings?) and interpreting them give birth to widespread debate fuelled by radical uncertainties which can only be resolved by making massive investments, by initiating vast and exceedingly costly inquiries. The local and the global are in constant interaction—the profits of the butcher serving the little town of Antony, where I live, are directly affected by a decision by John Major—and it is very difficult to distinguish between spheres of action or institutions separated by clearly defined boundaries, so complex has the fabric of the social structure become. Reassuring certainties give way to tormented perplexities.

The second relates to the conditions in which knowledge is produced, and more particularly, to methods of experimentation. In a ‘cold’ situation, it is enough to call upon the experts and their laboratories. But in ‘hot’ situations, experts or scientists on their own, working in their usual way—ie, shut away in their laboratories—can do nothing. In order to trace links, correlate findings, produce and test hypotheses, they will always be forced to deal with non-specialists. At a stroke, this turns the latter into key players in the production of knowledge and the processing of the measurements required to map out the externalities. Once again, mad cows and their prions provide a useful source of insights. There is no way of establishing the facts without organizing epidemiological studies, without shedding light on the networks for selling and distributing animal feeds, without implementing procedures for tracing animal carcasses etc. Society as a whole must agree to take action in order to produce an officially recognized body of knowledge and measurements—in the metrological sense—in the absence of which the existence and geography of the externalities cannot be regarded as defined; that is to say, without which measurements—in the political sense—cannot be taken with any legitimacy.

(iv) Not only are ‘hot’ situations becoming more commonplace, more visible and more pervasive, thereby indicating that our societies are now thoroughly permeated by the technosciences; but more importantly it is becoming exceedingly difficult to cool them down, ie, arrive at a consensus on how the situation should be described and how it is likely to develop. Externalities are at the centre of public debates with no obvious conclusions. Firstly, the experts tend to emphasize their differences, because they do not wish to run the risk of making facile commitments. Secondly, economic agents, can no longer be kept at a distance from the investigations which by the same token, they help to hamper: some of them have an interest in maintaining the state of controversy and ignorance 13 and do not hesitate to commit substantial resources to doing so because they can influence the content of conclusions by introducing arguments and problems hitherto absent from the debate.

(v) In this ‘hot’ world, which is becoming increasingly difficult to cool down, the work of economists is becoming ever more arduous because the actors they are tracking are faced by non-calculable decisions. This is the point at which it would make sense to draw up a new contract between sociology and economics. The anthropology of science and technology (AST) has acquired some useful tools for describing the dynamics of these confused situations or ‘hybrid forums’ (Callon, Law and Rip, 1986; Latour, 1987). Hence it is in a position to keep track of controversies and the experiments they engender without giving precedence to any one point of view, whilst at the same time revealing the socio-technological maps produced

by the actors involved as well as the progressive development of instruments for making world states calculable. Thus AST can help with the work of framing interactions by improving the visibility of various efforts to keep track of overflows as well as the visibility of the disagreements or agreements to which they give rise. Like those satellite imaging

systems that enable navigators to keep track of their relative positions at all times, the anthropology of science and technology can provide the actors with a cartographical outline of overflows in progress, thereby paving the way for preliminary ‘ negotiations.

While the anthropologist of science and techniques and the economist could choose to ignore each other without major inconvenience—the one fascinated by science as it is being brought into existence in laboratories cut off from the world, the other more interested in companies which, out there in the cold world, are applying science already in existence—their insights are becoming complementary and increasingly difficult to treat separately. Wherever they appear, the technosciences breed uncertainty and controversy: our societies are ‘hot’ thanks to the technosciences, which is why interdisciplinary collaboration is becoming essential to our understanding of them. This is the price we must pay if we wish to keep track of the mechanisms by which social spaces are formed in which decisions taken by actors with recognized identities and interests become calculable.

This does not necessarily mean that sociologists should be slaving alongside their fellow economists in order to ensure that a market can continue to exist whatever happens. Naturally some will decide to do so; others who are more critical or doubtful of the benefits of the marketplace will prefer to invest their energies in the production of charts designed to reveal the ever-expanding network of invisible and increasingly uncontrollable connections. The former will regard framing as the solution and so attach more importance to the effectiveness of cold calculation; the latter will be more interested in overflows and the heat they generate. But whatever they decide to do, they will be unable to evade the logic of framing/overflowing. They are already a part of it.

4. The negotiated market

On several occasions I have used the idea of negotiation to describe the relationships which come into being in hybrid forums: the actors negotiate their own identities and interests as well as the existence, nature and volume of overflows. The concept of negotiation, which lies at the heart of the analysis of science in the making, evokes the theoretical framework proposed by Coase in his analysis of externalities and how we deal with them (Coase, 1960). I intend to discuss this framework in more detail below. My aim is to show that once again, the different approaches are necessarily complementary.

For Coase, who is essentially preoccupied by the conditions governing intervention by the public authorities, agents are quite capable of sorting out the issue of externalities on their own, ie, of internalizing them by means of bilateral negotiations, provided that the two following conditions prevail: (a) property rights are clearly defined and (b) transaction costs are nil. Only in cases where property rights are difficult to establish (so in the presence of indivisible entities, for example: it is quite impossible to establish a property right to the atmosphere with a view to resolving pollution-related issues) is state intervention required. Coase proposes an elegant solution: the existence of an institutional framework which allows negotiations to take place.

This model is beautiful by virtue of its simplicity and the general applicability of the underlying hypotheses, but it presupposes the existence Of 0) identified agents (A, B, C and X, Y and Z in my definition), (ii) who are capable of negotiating with each other, ie, of defining their interests and measuring the benefits accruing to them or conversely, the harmful effects of which they are the victims;` Coase also needs (iii) overflows that have been confirmed and acknowledged and (iv) property rights allocated in such a way that the

identities and responsibilities of the source agents can be established, as can those of the target agents.

We have just seen that these hypotheses, which are straightforward enough in the kinds of situations we earlier described as ‘cold’, in reality become very cumbersome as soon as we turn our attention to ‘hot’ situations, where each of these conditions can only be satisfied by making substantial investments in order progressively to accumulate knowledge and create metrological frameworks. They are the result, rather than the starting point, of a lengthy ‘cooling’ process.

What Coase wants to avoid—and in this he adheres to a tradition with its roots in the political philosophy of the Enlightenment—is that state of nature in which conflicts and antagonisms are resolved by violence. Negotiation and the drawing-up of contracts: these are the methods of co-ordination that he holds up as the ultimate foundation stones of civilization.” But in his preoccupation with ‘cool’ situations in which world states are already known or easy to identify, Coase clearly forgets that this pacification is only possible if it is upheld by instruments that impose upon the agents’ subjective (and consequently irreconcilable) viewpoints the transcendence of instruments which—once they have found universal acceptance—guarantee the objectivity of the facts, to which everyone then agrees to submit. The very fact that negotiation is possible—or to put it another way, that human relationships are peaceable—has less to do with laws and institutions (a clear attribution of property rights) than with the existence of this technical infrastructure; ie, to the existence of these instruments and their infallible measurements. In order to achieve such measured behaviour—the word says it all—one must first prove that behaviour is measurable.

Thus Coase’s theorem only has a limited value. To fully convey this point it may be useful to draw a parallel with the distinction made between Newtonian physics (‘cold’) and Einsteinian physics (‘hot’): the world views and analytical instruments developed by these two paradigms are different but they are compatible when the ratio of the velocity of bodies in motion to the speed of light tends towards zero. Similarly, Coase’s theorem has considerable value in ‘cold’ situations, ie, when developments only happen slowly or, to put it another way, when the actions required to stabilize the actual world states and their descriptions are negligible, in terms of costs and commitments, compared to the difficult and demanding negotiations between agents attempting to reach agreement on the redistribution of resources or exchange of property rights. But things change once controversies start to dominate and situations start to heat up: now actions that involve the identification and measurement of externalities take priority. The emphasis shifts towards the production of an acceptable knowledge base and calibrated, certified measuring instruments that make it possible to map overflows with accuracy. As we have seen, if there is negotiation, it relates to the existence and nature of the overflows, to the identity of the source and target agents. Only once the controversy has been resolved can the other kind of negotiation—involving the transfer of resources, property rights etc.—begin. Those who like to set up family trees would put the negotiation regarding the existence of overflows at the top, because this is the one that determines how actors and externalities are identified. Without it, framing—in this case, the initiation of negotiations on property rights—is impossible. This distinction invites us to differentiate between two different types of negotiations: (a) negotiations aimed at identifying overflows, or ‘hot’ negotiations, and (b) negotiations aimed at framing them, or ‘cold’ negotiations. The creation of commercial relationships presupposes that both kinds of negotiations take place, one after the other.

Thus the concept of framing/overflowing helps us to understand why speeches—optimistic as well as pessimistic—on ‘the inexorable growth of the marketplace’ have no foundation in fact. If only because of the role played by the technosciences in what we are pleased to call advanced societies—technosciences which cause entanglements and networks of interdependencies to proliferate at their leisure—the market must be constantly reformed and built up from scratch: it never ceases to emerge and re-emerge in the course of long and stormy negotiations in which the social sciences have no choice but to participate.

Notes

- 1 Cf. Strauss’s groundbreaking work on the mechanisms by which the imminent death of a terminally-ill patient in hospital is made invisible in the eyes of the patient himself (Glaser and Strauss, 1965). This topic was examined in more detail by L. Star when she studied how ‘the prior and ongoing work disappears into the doneness’ (Star, 1991).
- 2 Externalities only represent one kind of market failure among others, from which they cannot easily be differentiated in their entirety: the public goods (which produce externalities which are generally positive); asymmetries of information and their effects (‘moral hazard’ and ‘adverse selection’); resources which are common property (ie, which are not owned by anyone but can be used by anybody).
- 3 The most radical presentation of the central role of objects in the framing of interactions is put forward by Latour (Latour, 1994).
- 4 Certain currents of symbolic interactionism, along with ethnomethodology, take this viewpoint (and support it by reference to arguments that are at once both theoretical and methodological).
- 5 A very orthodox viewpoint would certainly regard externalities as a purely involuntary—ie, accidental—effect.
- 6 It would be appropriate here to cite numerous works—in particular on environmental economics—that aim to formulate more effective procedures for framing commercial transactions.
- 7 Here I am arguing from the standpoint of constructivist sociology—ie, that society is an achievement—rather than that of structuralist sociology, which regards society as the medium in which actors are immersed and sometimes drowned!
- 8 This antagonism is summed up in masterly fashion by Duesenberry in his oft cited phrase: ‘Economics is all about how people make choices; sociology is all about how they don’t have any choices to make’ (Duesenberry, 1960).
- 9 Here we rediscover one of the basic truths intuited by H. Becker and A. Strauss: that actors belong simultaneously to several social worlds and any analysis must take this multiple identity into account in order to trace the dynamics of the interactions.
- 10 This proposal is merely the consequence of what we should probably call a new theory of action in which what counts are the mediations and not the sources: (Callon, 1991), (Hennion, 1993), (Latour, 1993).
- 11 It is possible to demonstrate the general applicability of this principle, which relates not just to the commercial transaction but also to the different methods of co-ordination. It is no easier to frame political relationships (between those represented and those who

represent them) or personal relationships between people to take just two well-known and omnipresent forms of interaction.

- 12 Mallard reminds us of the study undertaken by the monthly journal *Que Caesar* in April 1993: small reactive strips were included with the magazine enabling readers to measure the hardness of their water and its nitrate content for themselves: 'the darker the strip, the higher the level of invisible pollution' read the text accompanying the instrument, and it included a colour-coded list of numerical equivalents. As Mallard clearly demonstrates~ the role of these instruments goes far beyond their crucial contribution to the process of calculating respective interests. They also allow us to make the transition from economic space to legal space: a traffic pollution analyzer (CO/CO²) provides us with more than a figure: as part of a metrological framework in which every element is certified, it allows us to act directly on the legal decision-making process (Mallard, 1996a).
- 13 Tobacco companies played an important role in sustaining the controversy regarding the ill-effects of cigarettes. By financing the research, they have been actively contributing to the prolongation of a state of doubt and ignorance.
- 14 Those seeking to show the limitations or suggest a toned-down formulation of Coase's theorem must do more than simply point out the existence of transaction costs relating to the quest for and identification of the source actors, the reconstruction of the relevant information and finally, the negotiation itself. After all, the transaction costs are based on the assumption that the reality of the phenomena and the existence of the agents involved have been stabilized. But over and above that, what I have in mind are the actual conditions of a negotiation which is only feasible if agreement can be reached on how best to define the overflows. Such an agreement can only be achieved if calibrated measuring instruments are available.
15. It was the same century and the same authors who explored the concepts behind property rights to their limits. The philosophy of the contract and that of property rights are closely interdependent; see for example: Hesse, 1990; Woodmansee, 1984.

References

- Burt, R., (1992), *Structural Holes. The Social Structure of Competition*. Cambridge, Mass.: Harvard University Press.
- Callon, M., (1991), 'Techno-economic Networks and Irreversibility', in J. Law, *A Sociology of Monsters*, (ed.) pp. 132-164, London: Routledge.
- Callon, M. and Law, J., (1997), 'After Individual in Society: Lessons on Collectivity from Science, Technology and Society'. *Canadian Journal of Sociology*, 22(2), pp. 165-182.
- Callon, M., Law, J. and Rip, A. (ed.), (1986), *Mapping the Dynamics of Science and Technology*, London: MacMillan.
- Cassier, M., (1995), 'Les contrats de recherche entre l'université et l'industrie: les arrangements pour produire des biens privés, des biens collectifs et des biens publics' (Research contracts between universities and industry: arrangements for producing private benefits, collective benefits and public benefits). CSI-EMP thesis, Ecole des mines de Paris.
- Coase, E.R., (1960), 'The Problem of Social Costs'. *Journal of Law and Economics* (3): 1-44.

Duesenberry, I., (1960), 'Comment on 'An economic analysis of fertility---. In Demographic and economic change in developed countries, ed. The Universities National Bureau Committee for Economic Research. Princeton: Princeton University Press.

Friedberg, E., (1993), *Le pouvoir et la règle*. Paris: Le Seuil.

Glaser, B. and Strauss, A., (1965), *Awareness of Dying*. Chicago: Aldine.

Goffman, E., (1961), *Encounters: Two Studies in the Sociology of Interaction*. Indianapolis: Bobbs-Merrill.

Goffman, E., (1971), *Frame Analysis.. an essay on the organization of experience*. Chicago: Northeastern University Press.

Granovetter, M., (1985), 'Economic Action and Social Structure: The Problem of Embeddedness'. *American Journal of Sociology*, 91 (3):481-510.

Hennion, A., (1993): *La passion musicale*. Paris: Métaillié.

Hesse, C., (1990), 'Enlightenment Epistemology and the Laws of Authorship in Revolutionary France, 1777-1793'. *Representations* 30 (Spring): 109-137.

Latour, Il., *Science in Action*. Cambridge, Mass.: Harvard University Press.

Latour, B., (1993), *We have never been modern*. Essay in symmetrical anthropology. London: Harvester Wheatshead.

Latour, B., (1994), 'Une sociologie sans objet? Remarques sur l'interobjectivité'. *sociologie du Travail* (4): 587-608.

Mallard, A., (1996a), 'Des instruments i leur usage. Aperçu sur la coordination par la meagre'. In *Représenter, Hybrider, Coordonner*, Ecole des mines de Paris, edited by Cécile Méadel and Vololona Rabeharisoa, 179-187.

Mallard, A., (1 996b), 'Les instruments dans la coordination de l'action'. Thesis, CSI, Ecole des mines de Paris.

Polanyi, K., (1971) [1957], 'The economy as Instituted Process', in: *Trade and Market in the Early Empires*, K. Polanyi, C. Arensberg, and H. Pearson (eds). Chicago: Henry Regnery Co.

Richardson, G.B., (1972), 'The Organization of Industry'. *Economic Journal*, (September): 883-896.

Star, S.L., (1991), 'The Sociology of an invisible: The Primacy of Work in the Writings of Anselm Strauss', in: D. Maines (ed.), *Social Organization and Social Processes: Essays in Honour of Anselm L. Strauss*, Hawthorne, NY. Aldine de Gruyter.

Williamson, O., (1993), 'Calculativeness, Trust and Economic Organization'. *Journal of Law and Economics* XXXVI, (April): 453-486.

Woodmansee, M., (1984), 'The Genius and the Copyright: Economic and Legal Conditions of the Emergence of the "Author"'. *Eigh teenth- Century Studies*, 17 (4): 425-448.