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Civilizing markets: Carbon trading between *in vitro* and *in vivo* experiments

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Abstract

The creation of carbon markets is one of the solutions currently envisaged to meet the widely recognized challenge of global warming. The contributions in this special section of *Accounting, Organizations and Society* show that many controversies nevertheless exist on the ways in which these markets are organized, the calculative tools that are devised to equip them, and the role that they are supposed to play, especially in relation to other types of intervention which favour political measures or technological research. In light of these controversies, the article considers carbon markets as ongoing collective experiments. It is argued that carbon trading is an exceptional site for identifying the stakes involved in such experiments and for identifying better what the dynamics of civilizing markets could be.

In a recent interview on the BBC, Vaclav Klaus, the very neo-liberal president of the Czech Republic, stigmatized the red ecologists (sic), claiming that their actions were a threat to freedom. He added provokingly that the best way of dealing with environmental issues, especially the challenge of global warming or climate change, was to put all our trust in the market. As he sees it, the solution is not *less* but *more* market, the only appropriate policy being to remove all obstacles to its extension and development. The market frees initiatives, regulates the scarcity of resources and, in the long run, stimulates the innovations that will provide the solutions to humanity's problems. This extreme position, defended by a politician trained in the economics departments of US universities, has the advantage of explicitly raising the question of the role that markets should have in the global warming issue. But because it is limited to simply reasserting a general dogma, it says nothing about the only question that really matters, a question considered in detail in this special section of *Accounting, Organizations and Society*: the nature of the markets that should be set up and their forms of socio-technical organization.

Economists – not those who like Vaclav Klaus have lost all contact with academic research, but those who still think about the conditions of the functioning of real markets – fortunately show more perceptiveness and realism. They have not forgotten that economics has devoted a substantial part of its efforts to analysing market failures. Markets do indeed have unquestionable advantages that make them irreplaceable. Through the autonomy with which they endow economic agents, they stimulate creation and innovation. They are also a powerful

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tool for coordination. Finally, they facilitate adjustments and the search for compromises that are not as likely to emerge through other mechanisms such as plans. But there are two sides to every coin. Markets have intrinsic limits and their very functioning spawns matters of concern. From their first years at university, all economics student learn that markets are not well-suited to the production of public goods; they are a constant source of negative (sometimes irreversible) externalities which affect the existence of groups whose interests are not taken into consideration; they can do nothing or next to nothing about income inequalities; and they are not the best solution to guarantee everyone's access to certain goods such as healthcare. According to economists, these limits are real failures. Of course they do not doom markets as such, but they are an incentive to seek solutions and to introduce alternative means so that advantage can be taken of the benefits of markets while attenuating their negative and undesirable effects. Vaclav Klaus remembered only half of the lessons he had learned.

The global warming issue is a good illustration of what a reasonable approach, attentive to both the pros and the cons of markets, ought to be. This is for instance the approach adopted by Sir Nicholas Stern in his now famous report (Stern, 2007). He contends that global warming, of which the partially human origins have been established by scientific research, is the result of a huge shortcoming of economic markets. It is a perfect illustration of the damage that negative externalities can cause when they are produced on a large scale without the effects being felt immediately. Now that scientific research has made these externalities visible, tangible, measurable and predictable, the blindness of those who still chant on every note that *more* markets will save us from the weaknesses of existing markets is even more evident, for any extension of markets will naturally also entail new weaknesses. Stern's argument seems reasonable, at least in principle, as it excludes doctrinarian positions. The market is simply one solution among others, with its advantages and disadvantages; it should neither be diabolized nor considered as a panacea.

In my opinion this pragmatic attitude needs to be framed by two additional requirements. The first relates to the organization of activities concerning market design. In certain respects markets do indeed have unquestionable advantages and that is why it would be unreasonable not to take advantage of them. But their efficiency depends to a large extent on the socio-technical arrangements of which they are made (Callon, 1998; Callon, 2007; Callon & Muniesa, 2005; Callon, Muniesa, & Millo, 2007; MacKenzie, 2006; MacKenzie, forthcoming; MacKenzie & Millo, 2003). The design of these arrangements therefore becomes a strategic activity in its own right which is worth organizing after careful consideration. The second requirement, related to the first, pertains to the precautionary principle. No one, not even the best specialists, can be entirely sure in advance of the organizational forms and material *agencements* needed to establish a market's functioning. Concrete markets can be described and analysed *in vivo* only, which implies the establishment of devices for measuring, monitoring and watching them, to constantly keep an eye on the problems they pose and the way in which they react to certain interventions or adjustments. It is because a market is deployed in an uncertain world that it imposes this mixture of agnosticism and experimentation, of trials and errors, observation and evaluation of the effects produced, so typical of a precautionary approach – in this case applied to socio-technical artefacts and not only technological innovations.

The first requirement is fairly easy to acknowledge. Because markets are designed they should be designed well, with attention paid to quality so that all problems are properly identified. Social engineering has the same terms of reference as technical engineering and, like it, has to be organized formally. The second requirement, easy to accept in theory, is probably more difficult to put into practice. An experimental, agnostic approach, open to unexpected questions, prepared to carefully consider problems which arise and to hear voices raised, implies governance structures which are (still) cruelly lacking. Finally, the two requirements should not be considered separately. To be validated, design needs experimentation, and experimentation acts in turn on design (Roth, 2007). This tension between the two, on the basis of which markets are presented as reflexively designed devices and as on-going scale-one experiments, contributes to redefining relations between science, politics and economics, and to raising the question of the mechanisms through which boundaries are drawn between these different worlds. The aim of this introduction is to point out some directions for furthering our understanding of these mechanisms. From this point of view, reflection on the place, organizational forms and limits of carbon markets

does not only have the practical advantage of examining how the challenge of global warming should be met; it is also a contribution to more general reflection on what civilized as well as civilizing markets could be.

Markets as on-going experiments

Recent studies have shown that a growing number of markets are the outcome of genuine processes of experimentation. The contexts in which these experiments take place vary. Using a metaphor borrowed from the life sciences, Muniesa and Callon (2007) distinguish between economic experiments run *in vitro*, that is, in a laboratory[1], and experiments run *in vivo*, that is, in scale-one real markets. A good example of *in vitro* experimentation is the design and organization of spectrum auctions by the Federal Communication Commissions (FCC). As Guala put it, this is a typical case of market engineering which starts with laboratory experiments and in which various economists with their different models are involved (Guala, 2007). As in any innovation process, made of negotiations and compromises, the results are then tested outside the laboratory, where new interests come into play and new problems arise. From the first laboratory tests, the market is envisaged not only as a nexus of procedures and rules. Material and especially computer devices are a key concern and their design and development fuel debates and reflection, very often of a theoretical nature. This passage via the laboratory is obviously not a general rule. Experiments can be carried out *in vivo* or, in other words, *in situ*, without being prepared in a laboratory. Mechanisms are set up to identify the effects produced, the bugs encountered, and the reactions triggered, so that they can be taken into account and the architecture of the markets under experimentation altered. This happens frequently in cases of financial markets, for instance when stock exchanges are computerized (Muniesa, 2003). Whether the experiments are *in vivo* or *in vitro*, what is designed, tested and evaluated is a socio-technical *agencement* that combines material, textual and procedural elements. That is why the notion of an experiment is fitting in such situations: the objects being tested are not very different from those that we find in university or industrial laboratories working in the natural or life sciences.

I do not know examples of economic experiments which were shifted several times from one site to another while they were under way, alternating between *in vitro* and *in vivo* settings. Market mechanisms designed and tested *in vitro* receive much care and attention when they are first transposed into the real world, but after that they are seldom monitored and the feedback that could contribute to making the theoretical models more realistic is by no means systematically capitalized on. Symmetrically, economic experiments run *in vivo* are usually designed without planning or even envisaging the *in vitro* phases that would allow for more in-depth reflection on certain mechanisms or fundamental problems. The *in vitro* and *in vivo* worlds are thus carefully kept apart. Yet studies on innovation have shown that the absence of exchange, interactions, feedback effects and cross-fertilization is particularly harmful to the innovation dynamic (Kline & Rosenberg, 1986) (Akrich, Callon, & Latour, 2002). In concrete terms, such interactions can exist, in the case of markets or any innovation, only if soundly structured networks organize relations between the sites at which *in vivo* experiments are conducted and those at which *in vitro* experiments are conducted. Such networks should allow for the joint and coordinated advancement of knowledge and theoretical models on markets, on the one hand, and of market material and institutional devices, on the other. They could provide the organized framework of coordination and information trading between economics and the economy.

Carbon markets prefigure what could be networks of experimentation on markets

Carbon markets are an interesting example of what these networks of experimentation with markets could be, mainly because they are clearly defined as experimental, at least in the EU.

As Anita Engels shows in her contribution, the actors themselves and especially industrial firms consider that the creation of a carbon market is likely to be a long process due to the high level of uncertainty surrounding it. This attitude, shared by most of the stakeholders, creates a climate favourable to critical reflection, negotiation, ongoing evaluation, and learning by doing, using and interacting. These are test markets or, to use a software term, markets whose beta versions are being

[1] *In vitro* experiments include modelling activities as well as experimental economics.

tested. The EU has grounded its action in the same logic, with scheduled stages punctuated by reviews, and emphasis on the fact that certain measures or mechanisms are tentative, such as the distribution of free allowances rather than the organization of auctions to allocate them. This experimental approach is found at a more global level with the invention and establishment of Certified Emission Reductions (CER) in developing countries, as part of the Clean Development Mechanism. The CER are credits, not permits, but can be bought or sold and have a price and a market value. Unlike emission permits, these new 'products' do not seem to be the outcome of prior intense theoretical reflection. As fruits of the imagination of innovators in the wild seeking a compromise between the demands of the US and those of developing countries, they are perceived as forms of experimentation that are fiercely criticized and trigger numerous counter-proposals (Lohmann, 2005; Lohmann, 2006, this issue). For instance certain NGOs, having observed that labelled projects cause more environmental problems than they solve, suggest new evaluation or certification criteria (MacKenzie, this issue). The same uncertainties, trials and errors, and pragmatic approaches are found in the case of international organizations responsible for establishing accounting rules, which hesitate as to the categories to use to reveal these unusual products in firm's balance sheets (Cook, this issue). All in all, carbon markets seem to be experimental objects, all the aspects and components of which are tested, reflected on and critically evaluated.

Carbon markets also prefigure fairly accurately what interactive networks of experimentation could be, spread out in time and space. The various contributors to this section all refer to the theoretical and practical precursors of the European initiative (Braun, 2007). The origins of the constitution of carbon markets lie in certain economists' theories on the externalities produced by markets. Coase's seminal work immediately comes to mind, as well as that of all the authors who have discussed and enriched his analyses, especially Dales (1968). Without this contribution from economic theory, carbon markets would have been literally unthinkable. But the dissemination of models and their enforcement in concrete markets requires appropriate logistics. This is where networks of experimentation come in. Before they actually existed, carbon markets were not only conceived of in economics text books, they were also practised (as in rehearsed) on various occasions, in different places and forms – initially in the USA, with the first large scale experimental cap-and-trade programme (1995) for sulphur dioxide. Experiments have since proliferated, launched either by industrial companies like BP, or national governments, as in the UK, Norway and Japan. Significantly, all these sites, whether *in vivo* (universities) or *in vitro* (firms, nations, trans-national institutions), explicitly refer to one another. Interactions have been and are still organized, with capitalization on know-how and knowledge, and specialists circulating between sites. This is truly collective, distributed experimentation deployed in time and space, more or less chaotically or organized, but always explicitly. From this point of view the EU is a driving force: as the political history analysed in detail by Braun (2007) shows, it is a 'grand new policy experiment' that is being implemented. The intention is clearly to build up competencies, to develop a learning dynamic, and to construct networks of knowledgeable people and experts from all disciplines who commission studies and enrol both specialists and NGOs. This is how what can be called a community of practice (Amin & Roberts, 2008) or a collective of research and experimentation on carbon markets has come into being.

The advantage of studying carbon markets and their dynamics appears more clearly now. It can serve to further analysis and understanding of the more general process of constitution of collectives comprising large numbers of different actors from diverse temporal and spatial horizons, working on the conception and explicitation – mainly theoretical – of new market *agencements*. How, in these collectives, do theoretical models and practical solutions mutually interfere with and enhance one another? How is this collective work organized? What conflicts run through it? What mechanisms of coordination are used between the various protagonists or stakeholders? Alongside economics at large (including accounting, management science, etc.), what role does or could disciplines such as anthropology, the economic sociology, science and technology studies, and political science play? How are the different knowledge and know-how transported, experiences capitalized on, and evaluations conducted? How is professionals' work organized? What forms of inter-disciplinarity are set up, especially between the social sciences and the natural sciences (when models combine social and natural entities)? All these questions – and there are others that could be examined – concerning

the modalities of collective experimentation, are relevant to the role of markets, their design, and the modalities of their functioning.

Experimenting by taking matters of concern into account

The gradual, tentative setting up of these experiments on markets is an indisputable fact. The question is nevertheless whether this trend should be reinforced. Are such difficult and costly experiments really necessary? Would it not be simpler to rely on economists' expertise to devise the required regulations, and then leave it up to the agents to organize their activities? Is it not contradictory to frame the design of markets, institutions which, precisely, rely on agents' inventiveness and rationality?

An examination, even superficial, of the process of creation *ex nihilo* of new markets, in which everything needs to be invented – from the characteristics of the goods to the algorithms of pricing or the delimitation of the agents concerned, etc. – shows that neither economists nor the usual economic agents can accomplish this gigantic task alone. Not only do they have to cooperate and to accept the fact that other actors are involved; in addition, in a climate of prevailing uncertainty, even total ignorance (regarding the behaviour of natural entities and human actors alike), the design process must necessarily consist of a long process of trial and error. The belief used to be that markets were quasi-natural realities, and theoreticians were content to identify the conditions of their viability (with economists playing the role of midwives – or rather midhusbands! – of markets). We now realize that they have to be sometimes created from scratch, and that they are in reality fragile and complicated socio-technical artefacts. It is therefore necessary to reconsider the following basic questions: what are markets made of? How can we ensure that they function satisfactorily? To these two complicated questions, the recent but rich adventure of the carbon market controversies provides the beginnings of an answer.

• The setting up of a European carbon market has revealed the diversity of actors involved in its construction and functioning. For perfectly understandable reasons, stylized representations of markets tend to reduce the circle of agents to take into account, sometimes settling for the basic distinction between producers, intermediaries and consumers. Real markets would however rapidly collapse if they consisted only of these three groups, and carbon markets are a striking illustration of the inadequacy of these models. Simply listing the actors who participate actively, in different ways, in their conception and in the experiments concerning them and their evaluation, reveals an infinitely richer and more diversified population. We find the usual suspects but also scientists – whether they be climatologists, biologists or geophysicists –, grouped together in organizations like the IPCC which weigh heavily in the debate, as well as international organizations or coordination structures such as OECD, UNCTAD (The United Nations Conference on Trade and Development), IEA (The International Energy Agency), or UNFCCC (The United Nations Framework Convention on Climate Change), professional accounting organizations, academic economists, think tanks, NGOs of various convictions and, last but not least, the complex EU administration in Brussels with its national ramifications, its squads of jurists, and its in-house economists and their models. Each of these agents can and should be considered as economic agents in their own right: the specialist on greenhouse gasses devises a model that constructs equivalence between the different gasses and directly participates in fixing the price of emission permits; the accountant explicates the effects of climate change on the calculation of costs and investments; the economist designs market architectures, and so on.

We could argue that not all these actors are genuine economic agents because they are situated on the fringes and not at the heart of markets. In my opinion this objection is ill-founded, for at least two reasons. First, the modalities of the organization of carbon markets (like other markets in an experimental phase) are particular. Their functioning includes design and evaluation activities that constantly trigger reforms and interventions without which the market would implode due to the large number of highly complex problems. As market failures are constituent parts of these markets, and occur constantly, they have to be dealt with all the time. Second, in stabilized markets many of the actors who tend to be considered as marginal or peripheral are clearly present and particularly active. In which sectors does one not find NGOs pointing out the ecological or humanitarian stakes, public- or private-sector economists, consultants, think tanks, government officials fighting for new rules of the game, or researchers directly involved in developing new products that generate controver-

sies? Each of them, even if they are not directly engaged in commercial relations, actively participates in the design of markets and their functioning. The case of markets in the experimental phase seems to be appropriate for completing our description of market arrangements. No market is so stabilized, routinized, mechanized and purged of all uncertainty that it can entirely do without these design activities, including the framing and qualification of goods, the elaboration of rules of the game, the delimitation of agents to take into account, the construction of their calculative equipment, and so on. Once we have acknowledged this reality, we obtain a richer and more realistic picture, and at the same time a more complex one as we become more attentive to all the relations that form to enable a market to function. A car, a CER or an emission permit would not exist and could not enter into market exchanges without the anonymous crowds of humans and non-humans that have participated and still do participate in its conception, production, distribution and pricing, as well as the organization and supervision of all these relations.

- The multiple actors engaged in the functioning of markets all have their own expectations, conceptions, projects and interests, on the basis of which they promote different modes of structuring and organization. Through their disagreements over goods and their qualification, but also over the calculation of costs and prices, the evaluation of results or the taking into account of externalities and, more radically, their differences concerning the role of markets in controlling climate change, they reveal the potential diversity of forms of market organization. For example certain NGOs consider that the best solution is to leave carbon in the ground; others accept the idea of a market, at least as a partial solution, and think that clear criteria are needed to evaluate the demand for CER (gold standard); others refuse the idea that the market can be regulated or accompanied by taxes, and so on. These standpoints cannot be reduced to simple conceptions or ideological talk unconnected to a reality – that of concrete markets – seen to be external to them; they are, or tend to be, inscribed in devices which can be considered as experimental. Academic economists, who by no means agree on everything, are indeed important players, but they are clearly not the only ones to think and intervene. Carbon markets show that in a situation of uncertainty over the state of the market, the elements comprising it and the effects that it is likely to produce, one cannot judge its effectiveness and efficiency without taking into account all the assessments, points of view, projects and programmes developed by the actors who transform it in an on-going (open) experiment.
- What are these controversies about? What are the issues, the matters of concern, that markets produce and that the different actors involved in their functioning highlight, through the questions they raise? Studies inspired by STS, devoted to the analysis of market socio-technical *agencements* (Callon, 2007; Hardie & Mackenzie, 2007) are to my mind useful for introducing a tentative classification of these issues.

The first and most visible issue in the case of carbon markets, but one that concerns all markets, pertains to the framing and qualifications of the goods that are traded. In this case it is necessary to identify and characterize the various greenhouse gasses. As MacKenzie explains in the case of HFC 23, one of the problems is to measure in a unanimously acceptable way their impact on the climate (MacKenzie, this issue). Without the establishment of these equivalences, no economic valuation can be envisaged. MacKenzie shows the extent of the scientific, technical and metrological investments needed to stabilize the equivalences which, given the prevailing uncertainties, can be questioned at any time. A second issue pertains to the list of actors seen as taking part in the market. Agreement on this point is far from unanimous, as Lohmann illustrates so well. Unexpected actors, orphan or affected groups (to use the terminology that I have proposed in Callon (2008)), appear when no one was expecting them, for the good reason that they could hardly have existed as groups considering themselves to be concerned by the functioning of carbon markets before those markets were established. Here we see the dispossessed farmers; there the enraged neighbourhood inhabitants; elsewhere, in the countries of the North, spreading pollution caused by certain firms which increase their emissions after purchasing emission certificates in the South, etc. The proliferation of the actors concerned, whose emergence was impossible to foresee and who sometimes, directly or via spokespersons, end up becoming involved in the designing of markets, is a constant source of issues to take into account in adjusting the market architecture and specifying the modalities of its functioning. Calculative equipment, whether it serves to establish equivalences between chemical entities (for example to measure their effects on global warming), to price goods, to orga-

nize encounters between supplies and demands (auctions or other mechanisms), or simply to measure emissions, is also the subject of stormy debates and lies at the heart of the structuring of carbon markets. The list could be lengthened. It would show that each of the operations contributing to the formatting of the market socio-technical *agencements*[2] is found in a controversial and unstable form in the case of carbon markets. In other words, the description of the market and its functioning, that is, what the market is and what it does, cannot be separated from the multiple controversies concerning it, in which as many different versions are proposed.

Carbon markets thus invite us to enrich our conceptions of markets. Markets are not only devices enabling well-identified agents to defend their interests and to organize transactions so that they can reach satisfactory compromises efficiently. At the heart of markets we find debates, issues, feelings, matters of concern, dissatisfaction, regrets, and plans to alter existing rules, which cannot be internalized once and for all because they are linked to irreducible uncertainties, to what I have called framings which are never either definitive or unquestionable. This "hot" component of markets, which causes them to be in a constant state of disequilibrium, traversed by forces of reconfiguration, is not always present to the same degree but it always exists. The tension between the cold source and the hot source is a component of markets. In the case of those still in an experimental phase, such as carbon markets, the hot source is preponderant, for uncertainties are expressed through it. These markets, which act as magnifiers, show us that which is usually concealed or which we get rid of too readily by talking in terms of failures. I believe that it is more accurate and fertile to consider that any market includes both of these components. Carbon markets impose a new view of concrete markets. To the question: 'what are they made of?', they beg us to answer: of all the existing or emergent actors who are concerned by their functioning and involved in clarifying the problems and issues that they generate. To the question: 'what is a market that works correctly?', they suggest the following answer: it is a market which welcome and recognize as one of its most central constituent elements all the actors who demand to be taken into account, including those who are considered as marginal or on the verge of exclusion, with their points of view, their matters of concern, their proposed tools, framings and models. It is this dynamic tension, in which constant unexpected concerns are expressed and ask to be heard and to be taken into consideration, that defines a 'good' market (Law, 2004). The question here is obviously about the organization of this dynamic. It calls for specific solutions to each market, and finds answers only at the cost of an effort to organize the design and experimental activities of markets.

Politicization, economization and scientization: from (stem) issues to networks of specific and differentiated problems

A market which functions satisfactorily is one that organizes the discussion of the matters of concern produced by its functioning and the framings/overflowings that it entails. It takes those matters of concern into account and sets up procedures and devices designed not only to encourage the expression of problems which arise but also to facilitate the design and evaluation of theoretical or practical solutions to those problems. A definition such as this, which grants centrality to on-going open experiments and to the debates and controversies accompanying them, closely links distinctly economic activities and those that one would tend to qualify as political and that markets tend to exclude from their ambit. That is why the explicitation of problems revolving around the various framings/overflowings mentioned above and their "management" are not self-evident. Some think that it entails the risk of transforming markets into political arenas. Many others perceive it as a pollution of economic institutions by events that are out of place in them. Carbon markets show however how sterile this view of the economy can be. These markets can develop legitimately and efficiently only if they render such controversial events visible and debatable, as a source of material for experimentation. In short, for markets to function, in the sense defined above, there have to be arrangements, procedures and devices which are clearly not outside of them but, on the contrary, become an essential component of them (Callon, 2008).

[2] Callon and Caliskan (submitted for publication) propose a provisional list of these framing activities, including: framing of passive goods and disentangling them from active human agencies; framing and qualifying calculating agencies; enframing the market encounter; producing the price; market maintenance; objectifying «The Economy».

To analyse these nascent market configurations in which economics and politics are combined, it would be tempting to say that in any market, as in any activity, whether economic or not, there are implicit politics that we could call sub-politics (Beck, 1992) and that need to be identified clearly if we are to get rid of them. In short, the aim would be to purify the market of the slag polluting it, to remove the unsolved political issues disrupting its functioning, to externalize them and then, after a political debate, to revert to that market to frame and regulate it better. Recent developments in the application of STS to the study of economic activities have however shown the counter-productive nature of this type of approach. The distribution between the political and the economic is not anterior to the market; it is the outcome of the functioning of markets, of which it is a by-product, in a sense. The short history of carbon markets clearly illustrates this point. Their construction is not primarily about the drawing of a boundary that clearly and unquestionably separates the political in their functioning from the economic. Carbon markets defy this type of division. They produce issues, matters of concern that no one is sure whether they should be addressed politically, economically or techno-scientifically.

The carbon market experiment can be described as a threefold process of joint problematizations at the end of which the problems to be treated by either markets or political institutions or scientific institutions will temporarily be distinguished. We know, and Nicholas Stern acknowledges this in his report, that all three treatments are inevitable, but we do not yet know with precision how the distribution will or should be made. This approach implies that neither economics nor politics nor science can be considered as realities that have been stabilized for once and for all. What an economic market is and what it can do are the result of on-going experimental processes and series of trials of strength, the outcome of which is not predictable. The same could be said for what can be qualified as political or scientific.

By adopting this point of view of economy, politics and science in the making, are we not likely to sink into confusion and relativism? A few comments are called for to reassure those who may be afraid of such an eventuality. Carbon markets are, once again, going to be very useful in helping us to understand why we are not condemned to choosing between the devil and the deep blue sea, between social constructivism (that which is considered as political, economic and scientific is simply the result of a clash between groups struggling to impose their own points of view) and essentialism (there are one or more definitions of politics, economics and science, which provide objective criteria enabling us to say, *a priori*, whether a behaviour, way of thinking or device is political, economic or scientific). Since they are markets in an experimental stage, which simply highlight a feature common to all markets, they are a remarkable site for studying this process of joint reconfiguration.

(Stem) issues and problematizations

As Marres (2007) shows, the best starting point for studying this process of politicization is the notion of an issue or matters of concern. In the case under study here, the issue – at the origin of the initiatives presented in this publication – is climate change and particularly one of its components, global warming. I propose to reserve the term *issue* for such situations of initial shock, where there is still no indisputable formatting enabling us, for example, to say with any certainty that it is a strictly (or primarily) political, economic or scientific issue. We will therefore talk of an issue when the available codes, irrespective of what they are, fail to answer the questions raised by this issue (Barry, 2001). This is indeed the case of global warming which defies all attempts to reduce it to a problem that is either strictly economic or political or scientific/technical. Of course those who try to perform such reductions are not discouraged by such polymorphism, but they all come up against overwhelming difficulties. Whoever accuses capitalism or the market of being the source of all our problems, and claims that global warming is above all an political problem requiring political solutions, is suddenly confronted with economic issues that strike back. Whoever thinks that the issue is at last scientifically and technologically under control is soon faced with political demands that point out the persistence of glaring injustices and the resulting economic waste. Global warming in its current state is an issue that is unqualifiable, not in theory but in practice, for no framing is able to embrace it in its entirety. As the roots of the word indicate, an issue always finds an exit enabling it to overflow. It is protean, constantly changing as it spreads, irrespective of the frame into which we try to fit and enclose it.

Issues can be compared to stem cells which, as we know, are not yet differentiated and are therefore described as totipotent. They are an original state from which all the cells comprising the organism derive. Depending on the circumstances and the trajectory followed, they become liver or heart muscle cells, for example, or neurons of the cerebral cortex. Before reaching this state, they go through various stages of specification (we talk of pluripotent, multipotent, unipotent and then specialized cells) at which they can veer off in a different direction towards other destinies and types of activity. Nothing in a stem cell determines its future as a liver or heart cell, for example. Moreover, the changes it undergoes do not seem to be irreversible, for stem cells can be obtained from highly specialized cells. Issues are very much the same: they have a multiplicity of fates, specifications, qualifications and regressions, all equally possible and probable, but some of which will materialize only later, depending on the circumstances and trials encountered. Global warming is an issue (we could say a stem issue!) that is gradually being split into a series of distinct problems, some of which are qualified as political and others as economic, technological or scientific. Let us call *problematization* this gradual process of fragmentation and division of issues that evolves into the joint formulation of a set of different problems which in a sense, at least partially, are a substitute for the initial issue (on the notion of problematization see Dewey (1916), Callon (1980) and Rabinow (2005); on the notion of the division of problems, see Barthe (2005)). Problematization is a multiform dynamic since, in general (and this is what is happening in the case of climate change), the questions (political, economic, etc.) it leads to are both distinct from and interdependent on one another. Instead of talking of global warming, people increasingly refer to market efficiency, negative externalities, developing countries' right to development, international politics, technological innovations to promote, research to undertake, and models to improve, with each of these topics being closely bound to the others.

The dynamic of problematization of (stem) issues is a complex process, probably even more complex than that of the differentiation of (stem) cells! The transformation of an issue into well-identified problems – which can be addressed by planning specific actions – is never completely consensual nor total. For instance, in the case of climate change, some are still convinced that global warming is simply one aspect of the more general issue of growth and its legitimacy. For those who think that all our problems stem from there, no problematization of global warming is acceptable. They demand that the issue not be divided up, and that it be put back into a more general issue that makes it even less divisible! The movement downstream, towards highly specifiable and treatable problems, is thus refused. Basically the demand is that the issue remain a stem issue, through a movement of amplification going upstream. Another, at least temporary, source of failure of problematization may stem from the opposition that it triggers: certain groups are opposed not to the division of the issue but to the way in which it is split up and reduced, like those who, for example, refuse the boundaries imposed by the Stern report between economic treatment and technological treatment of the abatement of greenhouse gasses.

When undertaken, this multiform problematization leads to the constitution of a network of problems (what I called a problematic networks: Callon, 1980) whose content and extension evolve in relation to the translations that are attempted between problems. It is contingent on the configurations in place when the (stem) issue becomes public. In other words, the division of (stem) issues into specific problems, some of which are qualified as technical and others as economic or political, as well as the formulation and explication of these problems, are not random. For example, the possibility of seeing the emission of greenhouse gasses as a consequence of market failure (negative externalities), stems from the state of economic theory, from what it says about the limits of any market but also about the existence of a largely common agreement on what economic markets are and the way they function (well or badly). Likewise, being able to contend without any fear of being contradicted, that it is conceivable to develop technologies to abate emissions, proves that science and technology have reached a degree of maturity, robustness and objectivity that makes the legitimacy of certain evaluations and projects unquestionable and inevitable (at least in the fields concerned). We would need to continue this inventory to show in detail and convincingly how the instituted configurations weigh on current problematizations. In turn – and this is an open research question – the way in which problems are eventually formulated, the treatment chosen and the solutions proposed and implemented, act on the existing configurations and contribute to changing

them. The way in which the organization and functioning of economic markets are designed will most certainly emerge profoundly changed from the multiple and complex experiments in the European carbon market. Likewise, what we know or think we know about technologies, equivalences between greenhouse gasses, or the dynamics of climate change and of the distribution between anthropic and non-anthropic causes, will be altered drastically by the research undertaken in coming years and consequently what might be considered as scientific or technical questions will be redefined. Even the limits between established spheres will be revised: markets which constantly take into account the multiple externalities that they produce – especially the constitution of concerned groups scattered across the globe, unable to be heard and suffering from the effects of economic measures intended to abate greenhouse gas emissions – will no longer resemble markets as we know them today. They will force us not only to revise our market theories and our common conceptions of their functioning but also, above all, to alter our ways of distinguishing political and economic processes. As I have shown elsewhere (Callon, 2008), these markets of a new kind, which seem more open and civilized than those to which we are accustomed, combine devices that we previously attributed either to the economy or to expression and political action. This redefinition of the boundaries between categories of problems and activities, as the problematization advances, seems inevitable even if we have very few ideas on how it happens and the conditions favouring or impeding it.

I am convinced that carbon markets are an exceptional opportunity for furthering our knowledge of these mechanisms and studying the transformation of (stem) issues into networks of problems, the resolution of which is attended by a (partial and limited) reconfiguration of economics, politics and science, and relations between the three. Take, for example, the multiple and interdependent framings proposed by the Stern report with its careful delimitation of what has to be treated by either the market or political institutions or the technosciences. Do we accept this division and try to address economic problems, for example by deciding to somehow combine taxes and the auctioning of emission allowances? This is where we immediately stumble against issues that flow over the set frame (even if we have decided to concentrate only on economic aspects), such as the question of equivalences between the different greenhouse gasses. MacKenzie (this issue) shows that this measure, based on scientific modelling and metrological innovation, impacts on carbon pricing. Hence, the economic problem rapidly becomes a complex technico-scientific problem. The machine producing interdependent problems is running again. Sir Stern's nice neat framings become jumbled and call for the definition of new boundaries. The same creative confusion occurs if we start with a question such as: how can we scientifically evaluate, and thereby economically value, the effects in terms of greenhouse gas abatement of replanting a forest in a rural area of Brazil? Driven by attempts to make this protean issue of climate change manipulable and manageable, the formulations of problems proliferate and react to one another. Instead of a shock, trauma or complex issue, a dense network of problems appears, constantly moving as each problem is borne by one or more actors who identify with it. Carbon markets are an ideal site for studying the dynamics of this (never ending) process of joint problematization.

Trajectories of problematizations?

It is this multiform process of problematization of (stem) issues that we need to follow and study, so that we can avoid the two stumbling blocks mentioned above, essentialism and relativism, for the networks of problems stretch between the two. Dependent on existing categories but not determined by them, they are powerful machines of social reconfiguration. The dynamics of problematization does not obey a logic set in advance; in other words, there are no natural trajectories that, in one way or another, the problematization of (stem) issues follows. This is where the analogy between issues and cells stops, for cells change by following paths that may be unpredictable but consist of predetermined steps. We can nevertheless posit (as a provisional hypothesis) that the process of problematization of issues, in so far as it is contingent and singular, obeys rules which are generally describable.

The fact that (stem) issues do not follow typical trajectories that a natural history of issues could describe, is illustrated by the case of global warming and carbon markets. The context in which the climate change issue appears and the nature of the institutions that host and promote it (the IPCC, the Rio Conference, the Kyoto Conference, Euro-

pean multilevel governance) orient its treatment in certain directions which depend on on-going controversies and experiments. Greenhouse gasses do not disturb the world and do not contribute to changing it in the same way as GMOs or over-fishing in the Atlantic Ocean. To be sure, carbon markets are a good laboratory for studying social redifferentiation, but we must be careful not to seek general laws on the evolution of issues therein. Our focus should rather be on devising analytical categories for understanding the processes of problematization that these markets amply illustrate.

As experimentation progresses, new forms of organization and socio-technical *agencement* of markets are invented, for unexpected questions arise, to which answers and at least temporary solutions are needed. I have already mentioned several of them, presented in the articles in this section: a possible combination of carbon taxes and emission trading; the invention of certificates to enable developing countries to participate in the collective emission-abatement programme; the development of pricing tools; compromise between free allocation of allowances and auctioning; and modalities of treating allowances in firms' accounting. We could also mention (Braun, 2007) the debate on whether it is preferable to organize carbon trading upstream or downstream, and on the interesting point of who should be imputed with the responsibility of emissions and therefore the allocation of allowances (is China responsible for its industry's emissions, or the consumers in the US who buy its cheap products?). These problems, peculiar to the 'global warming' issue and to the particular circumstances in which it appears and prevails, stimulate the inventive and creative capacities of actors who are prompted to devise appropriate solutions.

This creative activity, whose outcome is strongly dependent on the specific nature of issues and problems that are being debated, is the main source of the new differentiations proposed and tested during the problematization process. Those who design and implement carbon markets by answering the questions that appear to them (or are put to them), try not to remain locked in existing frames. They test the fault lines or the biggest weaknesses of the existing *agencements* and, by following the gradients of resistance favourable to them, distinguish between that which will be considered as political and that which will be taken in charge and delegated to the market and thus to the economy. The consequence is an at least partial redefinition of the territory of economics, its rules of functioning and its organization. The effects are felt all the way through to the theoretical activity of market analysis. They affect economic modelling itself, which is thus confronted with problems that it had not entirely solved or even perceived (for instance equivalence or non-equivalence, in terms of market efficiency, between carbon taxes and the auctioning of emission allowances). Thus, step-by-step, a complicated political economics is constructed, which takes current problematizations into account. By ricochet, politics itself is at least partially redefined. Procedures of consultation are transformed, to take just this one, now well-documented example (Callon, Pierre, & Yannick, 2001). NGOs become legitimate and unavoidable partners, and the emergent concerned groups who demand, through spokespersons, to be heard and taken into consideration, can no longer be completely ignored. The way of organizing the international public sphere and of making visible problems qualified as political, changes as the organization of markets evolves. Science ends up being transformed and redefined: first, in its content, for models explicitly combine economic with climatologic and geophysical variables, and there is no reason for this interdisciplinary integration to stop; and second, in its organization, with the constitution of a world parliament of specialists (the IPCC) who, like any political assembly, negotiate the content of their reports among themselves and vote on scientific facts before making them public and passing them on to policy-makers. One day, for sure, this parliament will have to break open the circle of professional expertise; it will have to bring into the research collective researchers in the wild attentive to the events affecting emergent concerned groups. The shock of climate change has already triggered a series of other changes, of a different nature, in the way of designing and doing economics, politics and science, but also of distributing problems between the three. This threefold process which, through the treatment of issues and their multi-problematization constitutes a joint process of politicization-economization-scientification, constantly produces new differences from existing ones and attributes new significations to economics, politics or science.

These reconfigurations, designed to deal with global warming as a very specific issue, could turn out to have a more general impact, so that the solutions tested in this specific case can be adapted and transposed to other situations. That is why it is

interesting to consider, at least in simple terms, for exploratory purposes, whether these reconfigurations and the redistributions that they entail can be characterized in general terms.

Market organization could henceforth explicitly include a set of actors who were formerly on the fringes of markets and are now at their centre. Carbon markets provide what is, in my opinion, a fairly good idea of that list mentioned above, which includes scientists, specialists in the natural sciences (such as climatologists or geophysicists) or the social sciences (such as economists, anthropologists or sociologists), accompanied by a squad of experts and representatives from NGOs, think tanks, international bodies and other political administrations. To be considered as efficient, a market should pay very careful attention to the numerous matters of concern that it creates, and to the groups that express and promote them, thus becoming economic agents in their own right. This surely requires that the usual market mechanisms (revolving around, for example, rules of competition, circulation of information, etc.) be completed by a set of procedures and devices designed to compile the list of actors to involve, but also to make an inventory of matters of concern, to make them explicit and debatable, and to organize experiments and evaluation of solutions devised and then adopted.

The political devices that take shape before our eyes could also be transformed by this still emerging reconfiguration of markets. In their new form they are destined to include actors who ask questions not only on the role of the market (in the singular), which is not unusual, but above all on the actual organization and on the effects of particular market*s* (in the plural). The social engineering of markets could thus become an explicitly political issue. This could lead to actors hitherto excluded from or considered as external to the world of politics being granting an unusual place and role in the debates but also in decision-making processes. For this to happen, the creation of procedures that we have proposed to call dialogical could be demanded. The idea would be to allow for all the actors concerned by the design and functioning of a particular market to be identified and to express themselves, and then for their analyses and proposals to be compared. Active participation in the negotiations and debates by scientists and experts, whether they are confined researchers or researchers in the wild, would be encouraged (Callon et al., 2001).

The way of practising science and producing knowledge could likewise be affected profoundly. The creation of the IPCC – a radical innovation in the organization of research and the procedures for validating scientific facts – as well as the engagement of a multitude of experts from a wide variety of organizations (mainly NGOs), point to a new type of community or rather a research and innovation collective which, I predict, will spread through many sectors if the appropriate adjustments are made.

In this emergent configuration – which has inherited from the preceding one but is also reshaping it profoundly –, with markets thus revamped, political devices and procedures rearranged, and research and innovation collectives redesigned, the same actors regularly participating in all three forms of activity remain distinct but are now explicitly inter-related. It is moreover this overlapping that allows for the multi-problematization of issues and their treatment 'in batches', as they are sliced up into as many specific problems to solve. It might be that we are moving away from a world broken up into spheres, with a two-way trade between them; but the new world we are entering into has not for all that abolished the differences: it simply distributes and treats them differently.

Conclusion

I hope that the articles in this special section will convince the reader that carbon markets are an exceptional field for furthering our understanding of the joint processes of economization, politicization and scientification through which the forms of organization of economic, political and scientific activities, their mutual relations and the challenges they are designed to meet, are redefined. In the establishment of carbon markets we are witnessing a redistribution of economics, politics and science, which does not eliminate differences but, by maintaining these distinctions, refuses to consider that their content is immutable. The social sciences, along with the knowledge elaborated by the actors, are stakeholders in these processes of experimentation consisting of constant feedback on the significance and impact of what is under way and on the measures to take (which will affect current differentiations between economy, politics and science). I think that they could be instrumental in clarifying the new models whose emergence and establishment we are witnessing and, why not, in their possible

generalization and transposition. How, in these conditions, can a civilizing process not come to mind, since in the final analysis this is a matter of plunging markets back into the social fabric which they help to create and which, in turn, constitutes the framework of the questions, expectations and needs to which they try to respond. The challenge of climate change could be one of the first opportunities on a planetary scale to raise the question of how to better civilize markets. The term civilizing markets, which I have chosen, following MacKenzie, as a title for this introduction, is even richer in meaning (Latour, forthcoming). Not only do markets need to be civilized, that is, to be included in this multi-problematization that is a living source of questions, research and the invention of satisfactory answers; but simply by participating in this movement they can act also as a civilizing force in politics and science. Civilization may be this never-ending effort to transform unsolvable issues into solvable problems, and thus to prove right Marx's claim that humanity never asks itself questions that it cannot solve. But we still need to establish why it asks itself certain questions rather than others, and that, in my opinion, is the whole point of studying civilizing markets.

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