Risk and responsibility in a manufactured world

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Abstract

Recent criticisms of traditional understandings of risk, responsibility and the division of labour between science and politics build on the idea of the co-produced character of the natural and social orders, making a case for less ambitious and more inclusive policy processes, where questions of values and goals may be addressed together with questions of facts and means, causal liabilities and principled responsibilities. Within the neo-liberal political economy, however, the contingency of the world is depicted as a source of unprecedented opportunities for human craftsmanship, rather than of possibly unmanageable surprises. Gene technologies offer a vantage point for reflecting on the consequences of the drift from discovery to invention as a master frame in the appraisal of human intermingling with the world. Biotech patenting regulations carve out a sovereign agency which, by crafting nature, crafts also the distinction between manufactured and non-manufactured world. Difficulties in responsibility ascription stem as a consequence. It is likely not by "democratizing" knowledge production that politics and economy can be democratized and responsibilities rearranged, but rather the reverse.

Keywords: risk, uncertainty, responsibility, science-policy relationship, gene technologies, neo-liberalism, discovery and invention

Introduction

In recent years sustained criticism has grown in the field of science and technology studies (STS) over traditional understandings of risk, responsibility and the science-policy relationship. Such criticism builds on the idea that the natural and social orders are "co-produced". In this view, scientific facts are neither a mere registration of reality nor the epiphenomenon of social and political interests. Rather than of discovery, knowledge is a matter of invention or manufacture; yet this means more than just "social construction": it is the result of human intermingling with materiality. Drawing on this argument a case is made for less ambitious and more inclusive policy-making. Current developments in techno-science point however to the opposite direction. Neo-liberal political economy equals the contingency of nature to unprecedented opportunities of commodification and appropriation. In front of that, the critical capacity of STS scholarship may find itself short of breath.

The article aims to outline the basics of this argument. I first retrace the development of, and connections between, risk, responsibility and uncertainty, with special reference to the growing relevance of an epistemic understanding of the notions. On this background I address the debate over the science-policy relationship and delineate the co-production approach. The case of biotechnology patenting provides insight into the consequences of the drift from

discovery to invention as a master frame in the appraisal of human intermingling with the world, according to a neo-liberal understanding of agency. The narrative of co-production in STS and in current techno-science discourses, regulations and practices merge and mismatch at the same time. This, I suggest, indicates the need for a renewed account of the interplay of nature and society.

Risk and responsibility

One of the most relevant, enduring aspects of modernization is the emergence and success of the notion of risk. The term spread in Europe in the XVI-XVII centuries. Initially it refers to the agent-independent threats of sailing, like storms or pirate attacks. Subsequently, however, risk was increasingly taken to designate events related to behavioural choices [33]. This is basically the present understanding of the notion. As currently used, for example, the notion of seismic risk does not refer to the possibility of earthquakes in themselves, but to the consequences of earthquakes as related to building techniques or emergency plans.

There may be little doubt that pivotal to this semantic drift is the emergence and strengthening of the figure of the modern rational individual: an autonomous centre of decisions who before an open-ended future, plans his action according to calculations of means-ends connections. Risk, therefore, is not only a matter of decision, but of predictability of outcomes; taking risks is deciding upon the reliability of forecasts, the controllability of events.

The development of probability and statistics is of obvious relevance in this respect. In the XVII century knowledge and opinion – what in medieval thinking was true by necessity, thus subject to proper demonstration, and what was true by testimony, subject to mere approval by authorities or respected judges – merged into the notion of "natural sign": evidence given by things themselves, from which generalizing inferences can be made. Within this framework probability, as "worthiness of approval", depended on the frequency with which predictions turned out to be correct [17]. This equated to transforming "a radically indeterminate cosmos into a manageable one, [reducing] uncertainty to the same calculable status as that of certainty itself" [42, p. 237], handling physical and societal processes without controlling every single element of them. Since the XVIII century governments have increasingly looked at, and relied on, statistic regularities and calculation mechanisms, with consequent, major changes in the character of political power [12].

Probability can mean either that it is possible *for* something to happen or it is possible *that* something will happen. The former refers to states of the world independent of any observer, concerning "stochastic laws of chance processes" (rolling the dice is the typical example); the latter refers to cognitive states of agents, concerning "reasonable degrees of belief in propositions"[1] [17, p. 12]. Throughout its history probability keeps track of this double reference, which we may call ontological and epistemic. However, an agent-centred notion of risk is clearly biased towards the latter.

If risk has become a master frame of modern society, the same can be said for responsibility [52]. The crucial period is again the XVIII century, when the notion of responsibility began to be used to designate the relationship between rulers and constituencies, or the obligation to repair a damage or suffer a punishment [35]. The connection between risk and responsibility is of course not only historical, but also conceptual. The idea of a free, rational, autonomous agent is as necessary for the notion of

[1] For example, "if you pull that handle too strong, you will break it".

risk as it is for the notion of responsibility: the cornerstone of the latter is imputability[2], that is the possibility to trace an action back to an agent as its causal factor; and causality is understood as "free causality" or free will [18], that is choice. Responsibility, therefore, is conceived as a matter of forecasting and deciding, that is taking risks. As a rule, moral or legal responsibility do not apply to a constrained or unwitting behaviour, unless such situation is imputable to agents themselves. The basic feature of this view of responsibility – we may call it, following Iris Marion Young [58], the "liability model" – is thus its being based on factual beliefs about the causal chain connecting events and agents, as detectable by the agents themselves. This is what Max Weber has in mind when he talks of the "ethics of responsibility" [54]: the attitude of a rational, autonomous decision-taker, who regards his own predictions as conditions or means for achieving an ethically valuable goal.

From risk to uncertainty

The limits to prediction started to be conceptualized in the 1920s. The emerging notion of uncertainty, however, was moulded on that of risk. It therefore retained the agent-centred, control-oriented bias of the latter. In physics, Werner Heisenberg's indeterminacy principle defined uncertainty as a limit to the measurement of physical states. In economics, Frank Knight connected uncertainty with the creative action of the entrepreneur [28]. John Maynard Keynes's distinction between objective and "personal" probabilities [27] was subsequently developed, among the others, by Leonard Savage with his notion of subjective probability [47], as referred – according to a Bayesan approach – to the agent's state of knowledge, instead of the character of phenomena. In this way "uncertainty owing to lack of knowledge is brought down to the same plane as intrinsic uncertainty due to the random nature of the event under consideration" [6, p. 10]. The possibility for something to happen is conflated with the agent's cognitive standpoint about such possibility. Uncertainty may eventually be seen as a special case of risk (when probabilities are all equal), rather than risk being a special case of uncertainty (when the possible occurrence of events is calculable): "If we insist that we are 'completely ignorant' as to which of the events $E_1 \ldots E_n$ will occur, it is hard to escape the conclusion that all the events are equally likely to occur" [34, p. 103].

With neo-liberalism this epistemic, subjectivist understanding of uncertainty takes a further step. The neo-liberal ideology, or narrative[3], portrays the individual agent as the most important player in society, and sees it as acting in the complex, open-ended task environment created by global trade and innovation-based competition [19, 20]. The agent's choice is therefore regarded as grounded on reasonable, prudent foresights, rather than the calculations of predictable risks typical of traditional entrepreneurial figures and welfare institutions [38, 39]. Uncertainty, as a consequence, is no longer considered a restraining, but an enabling factor. Contingency is equated to lack of constraint, rather than lack of order. Agency expands together with world instability, retaining its capacity for control over the events.

This has profound normative effects. What was previously regarded as a source of possibly unwelcome and unmanageable surprises becomes a source of opportunities, open to individual craftsmanship. Addressing this point in a comprehensive way would entail a lengthy analysis of neo-liberal narratives and policies, which is out of question here. Later, however, I provide an example of how the combination of uncertainty and controllability is

[2] Another conceptual dimension is answerability, that is justification of one's own conduct in front of a judge, provision of adequate reasons, explanation of the motives lying behind such conduct. I cannot elaborate on this point here.

[3] We may talk of a narrative whenever an attempt is made to make sense of the world, giving salience to and logically connecting actors, institutions, events, discursive and material aspects of life [13].

concretely worked out.

This vision of contingency as enhanced manageability stands in stark contrast with public concerns over techno-science's "unwarranted" claims of prediction and control; an unease that grew in the 1980s and above all the 1990s and 2000s [8], thus in parallel with the spread of the neo-liberal narrative, programmes and policies. Various, possibly overlapping, reasons have been suggested for a mounting criticism that clearly entails an opposite account of the implications of uncertainty for human agency. Some, for example, stress the increasing import and people's awareness of the unforeseen "side effects" of techno-science [1]. Others remark that the advancement of science produces disunity, differentiation of sound, meaningful cognition, making knowledge increasingly questionable – and questioned [46]. Still others – think of Alvin Weinberg's concept of "trans-science" [55] or Silvio Funtowicz and Jerry Ravetz's notion of "post-normal science" [15] – maintain that unmanageable uncertainty gains relevance because of the extended scope of human intermingling with nature (that is the extended scope of decision), the classic laboratory-confined trial and error approach becoming increasingly inapplicable because of the size of the phenomena addressed, the implied decision-stakes and, frequently, the urgency of decisions.

Be that as it may, the tension between these accounts of the implications of uncertainty and the neo-liberal view is evident. One may object that while science deals with the biophysical world the neo-liberal agent's environment is eminently social. Yet economy is especially central to neo-liberalism[4], and economy is the activity by which humans deal with materiality first of all for answering their material needs. On the other side, from the outset modern science has been oriented towards the manipulation and control of the material world, in the XX century becoming increasingly intertwined with technology and economics [44] – when Funtowicz and Ravetz talk of decision-stakes they are not actually referring to curiosity-driven research questions, but to corporate and public policy-related ones. In short, there is hardly any clear-cut distinction between economic and techno-scientific task environments. Contrasting accounts of uncertainty – as enhancing or constraining human agency and control over biophysical events – underlie, I will argue, mismatching accounts of the implications of techno-science knowledge production.

Uncertainty and responsibility

Before addressing this point, however, it is worth reflecting on the relationship between uncertainty and responsibility. The idea of liability, we have seen, is linked to risk understood as predictability and control (control by means of prediction). Faced with major environmental challenges, however, Hans Jonas [26] and many after him have argued that policy action has to deal not only with short-term, predictable consequences of choices, but with long-term, envisaged yet unpredictable outcomes. On this view, the ethics of responsibility seems to extend its scope beyond its original, calculative limits. Yet, can we still talk of an ethics of responsibility?

If we think, for example, of the controversies over climate change, nuclear waste or gene technologies, we notice that in all these cases the issue is not only, or not so much, about how *much* evidence is available, but *how* evidence is evaluated – what counts as evidence and what such evidence reveals – and by *whom*. Do successful predictions about events or outcomes of actions suffice to say we know enough to properly control things? Are observed deviations or emerging surprises negligible? Who is entitled to answer these questions? Who

[4] A major neo-liberal tenet is that politics loses relevance because of the growing technicality of issues, the non-negotiability of economic imperatives and the self-interested, utility-maximizing character of politicians themselves [19, 20].

is responsible if something goes wrong? Some, for example, regard gene technologies as just a follow-up of traditional biotechnologies; they only work more precisely and purposefully. They transfer single genetic traits under the assumption that identified features can be isolated from their original task environment, with the unknowns about the latter deemed irrelevant to the purpose. Critics maintain that this is an unwarranted, possibly dangerous postulation. The ones and the others appeal to "scientific facts". Yet what is regarded as a relevant fact is affected by value commitments: for example, about the benefits of growth and innovation, the resilience of ecosystems, the data needed to draw conclusions. Factual claims are made under the assumption that such commitments are sound and agreeable, which is usually taken for granted rather than openly debated [57].

Lying behind this type of controversy are two contrasting assessments of uncertainty, which entail divergent normative orientations: towards the ethics of responsibility or the ethics of principles – the latter, according to Weber [54], is the belief in the unconditional value of a commitment, regardless of its consequences. If uncertainty is deemed controllable, what is known is regarded as sufficient for taking reliable decisions. Uncertainty does not affect the expected results beyond a definite, accepted limit. Decisions thus fall within the scope of the ethics of responsibility. If uncertainty is deemed beyond control, the unknown is considered to hamper reliable predictions. It may affect in unexpected ways the outcomes of behaviour. Then a principle (like precaution: for example expanding the "safety belt" around a substance well beyond the threshold of observed effects) may offer a clue to the world order. To apply the principle means to behave according to such an order, thus to contribute to reproducing or (re)establishing it. One may not know (enough of) the causal chain, yet if action is consistent with the world order, then the unknown will operate according to such an order, in the long run at least [40][5]. Adverse consequences (like heightened costs) are therefore negligible, to the extent that they are marginal to the final result (enhancing health protection).

An example of the link between lack of control and ethics of principles is the "social connection model" of responsibility proposed by Iris Marion Young. Focusing on structural injustices, that is "social processes that put persons under a systematic threat of domination or deprivation of the means to develop and exercise their capacities" [58, p. 114], she finds them embedded in extended, loose social connections, to which the liability model cannot be applied. For example, according to a liability approach, consumers cannot be held legally or morally responsible for worker exploitation or hazardous emissions occurring somewhere in the world, along intricate production chains. However – Young argues – since they play their role in the social arrangements that enable exploitation and hazard production, consumers should take up their own part of responsibility. Yet how, given their limits of insight into the relevant chains? The answer is that, even if the search for properly predictable courses of action is hampered, it is still possible is to "carry out activities in a *morally appropriate* way and *aiming for* certain outcomes" [58, p. 119, italics added]. In other words, when uncertainty is perceived as hampering proper control over future events, responsibility assumptions and ascriptions are essentially connected to the agents' normative commitments.

Uncertainty, responsibility and the science-policy relationship

Modern science established itself as an institution specialized in the production of knowledge about material reality, on which political and religious powers have no legitimate competence. As the famous dispute between Boyle and Hobbes over the air pump indicates,

[5] If there is no order whatsoever in the world any purposeful action is obviously pointless.

this was perceived as a deep break in the social order [29, 49]. Nowadays the science-politics relationship has gained saliency again, as a core point of many environmental and techno-scientific controversies.

The traditional view of the division of labour between science and politics is at the basis of the case for the "social contract for science" famously made by Vannevar Bush in 1945 [4], subsequently stated again many times [e.g. 8]. Science is depicted as ensuring a reservoir of knowledge for answering social needs, thus as the premise to rational, efficient policy-making. Sound science has nothing to do with politics; at the same time, and for this very reason, "the policymakers' maxim should be 'science first'" [11, p. 310]. Policy questions, in this view, can be always reduced to quantitative risk-benefit analyses. The liability model of responsibility can be applied to both experts and policymakers, with regard to their respective fields of action.

The social contract narrative has clearly a normative purpose. It seeks to legitimize a tightening relationship between science, politics and economy stemming from a set of matching needs: the need of money of an increasingly technology-dependent science and the need of science of increasingly innovation-dependent politics and businesses. However, this narrative inevitably results in the opposite of what it pleads for: the growing politicization of science. If policy presupposes science, scientific debates become political debates, the conclusions of the former entailing answers to the latter [41]. Moreover, uncertainty cannot always be reduced to risk. Saying that non-calculability means equal probability entails conflating risk with bet[6]. Also, future events may simply be unknown [56].

This does not necessarily mean, however, a blurring of science and policy. According to a different, more recent narrative [36], a sharp distinction is to be made between science-based risk assessment and risk management, where the translation of scientific evidence into policy measures may be legitimately weighted against social and political considerations. In this sense, for example, the European Commission maintains that precaution is a risk management approach, applicable "when scientific uncertainty precludes a full assessment of the risk" [7, p. 12]. According to a variant of this narrative, no proper distinction between risk assessment and risk management is actually possible, since "non-scientific considerations play a distinctive up-stream role setting the framing assumptions that shape the ways in which risk assessments are constructed and conducted" [36, p. 7]. Yet the experts' task is still to bring out objective elements for evaluation; that is, to shed light on policy alternatives, distinguishing those compatible with data from those that are not. In other words, scientific questions may be framed by political ones, yet within a given political frame policy options are independent of political opinions [41]. Experts may thus perform their "objective" analyses in a traditional sense, making the liability model of responsibility fully applicable.

A growing number of scholars, however, remark that, for any significant level of controversy, definite, agreeable distinctions between policy and politics (or facts and values, risk assessment and management, knowledge and power) are virtually impossible. "Uncertainty estimates are in part a measure of the psychological state of those making the estimates, which is in turn influenced by the political context" [46, p. 393]. The tighter the intermingling of science with political (and judicial) power, the more difficult and controversial the politics/policy distinction. The more the decision seems urgent and the stakes high, the less the available evidence is regarded as sufficiently reliable. Climate change is a typical case in point. Waste is another: decades of study of percolation from repositories have increased the controversies over the sufficiency of evidence for decision making [46].

The stronger version of this position upholds what we may call an ontological, rather than an epistemic, account of uncertainty. From an epistemic viewpoint uncertainty *depends on*

[6] I may be presently unable to calculate the probability of two events, therefore for me they are the same, yet additional information may subsequently show that I was wrong.

decision-stakes (or vice versa): the growing scope of human agency entails for bio-physical processes to increasingly lay over control [15]. From an ontological viewpoint uncertainty *expresses* decision-stakes (or vice versa): the social and natural orders are co-produced. "Science offers a framework that is unavoidably social as well as technical since in public domains scientific knowledge embodies implicit models or assumptions about the social world" [22, p. 2]. In other words, "the ways in which we know and represent the world (both nature and society) are inseparable from the ways we choose to live in it" [24, p. 2]. There is a "continual interpenetration of political choices or commitments and the production of reliable knowledge" [25, p. 23]: policy "influences the production and stabilization of knowledge, while knowledge simultaneously supports and justifies that policy" [32, p. 84].

In this view, as argued by pragmatist philosophers, knowledge is dependent on the goals for which it is produced (and vice versa). It is impossible to know the world without acting upon it. Similarly, for Foucault (who represents a major inspirational source of the co-production narrative), historically situated fields of knowledge and processes of truth making include the objects under discussion. "The types of objects in their domains [are] not already demarcated, but [come] into existence only contemporaneous with the discursive formations that [make] it possible to talk about them" [45, p. 96]. The world is contingent in the sense that the way things are is not independent of the way we get to know them. It is manufactured in a stronger sense than a mere epistemic relativism. Scientific objectivity means the presence of objects, which means something able to object to what is said about it, by producing "proofs", "reliable testimonies" within an experimental framework [51]. Facts are given just because they are made.

Two major normative consequences stem from this account. First, if facts are entangled with values and environmental uncertainty grows with the decision-stakes, then one should adopt a less ambitious, less inflated view of human ability to master nature. Rather than continuing to claim ever-growing predictive and control capacity, it would be important to make an exercise in humility, recognizing that in many cases, from climate change to the effects of gene and nanotechnologies, we can improve at best our explanatory capacity [6]. Policy choices should therefore be oriented towards being adaptable, reversible, small-scale, technology diversified.

Second, if it is impossible to know the world without acting upon it, if knowledge has always a negotiated quality, intimately connected with the social order, then there are no actors with exclusive or even privileged access to facts. "Science's voice, we have learned to recognize, is one of several social voices that must be heeded in a fragmented, uncertain world. How to accommodate the voices of science with those of democratic pluralist politics is the central challenge" [10, p. 74]. The "social contract for science" and the implied division of labour, should therefore be revised. What is needed is a "democratization" of knowledge production and application, opening it up to broader constituencies than those usually admitted (experts, professional politicians and organized interests), namely to the end users of technology, affected groups and the general public [15, 22, 56].

The co-production narrative, in other words, draws from its own premises the demand for a more equitable stance among the parties involved in an issue, whatever their cognitive pedigree. When predictive knowledge is limited and the outcomes of actions are uncertain choices must be grounded on social agreement, which in today's society means they must be democratically debated, with no privileged role for aristocracies of any kind (cognitive, political, economic, or moral). The expert-lay citizen divide usually found not only in traditional policy processes but also in inclusive deliberative arenas (consensus conferences, citizen juries etc.) reproduces the social order and its inbuilt inequalities by defending its cognitive order [21]. Truly "extended peer communities" [15, 56] are instead those where questions of values and goals can be addressed together with questions of facts and means,

causal liabilities and principled responsibilities, with no preliminary adjudication of which is which and what pertains to whom.

Neo-liberalizing the world: the case of gene technologies

"An idiom, a way for interpreting and accounting for complex phenomena, [more than] a fully fledged theory" [24, p. 3], the co-production perspective has to be contextualized in the broader field of STS and environmental sociology. The latter has been characterized for many years by a quarrel between realist and constructivist approaches. Some scholars argue that "material, natural or non-social phenomena must be seen as having causal efficacy, and that it should be possible to make (objectivist) claims about their reality" [3, p. 299]. An example is Merton's idea of science's institutional exceptionalism. Its unique combination of principles (universalism, communitarism, personal disinterestedness, systematic doubt) allegedly makes science able to provide veritable accounts of reality. For other scholars, instead, "objectivity is a social phenomenon" [2, p. 141]. Facts are "products of socially negotiated understandings about the natural world, things whose status is to be explained rather than taken for granted" [23, p. 62]. The sociological deconstruction of scientific knowledge has often taken a negative stigma in the broader scientific milieu, being repeatedly attacked by natural scientists, as testified by the so-called "science wars" of the 1990s [e.g. 50]. Within social sciences, however, realists blame constructivists not so much for entering into the traditional paradox of relativism (if everything is relative, why should this very claim be absolute?), as for weakening the possibility of social criticism. "Treating global environmental change… as a social construction discourages investigation of the societal causes, consequences and amelioration of global environmental problems" [5, p. 20].

By providing insight into the intertwining of sociality (science, business, politics) and materiality in an allegedly knowledge-dependent society [16], the co-production approach seems able to surmount this debate. In front of a "conventional wisdom [which still] takes for granted that in any policy decision making, scientific facts… must precede any exercise of values" [10, p. 77], the framework of co-production seems to represent the "edge" of social science critical capacity, the basis of a reformist project sometimes explicitly advocated [30], where democratizing knowledge production is depicted as premised on – or at least strictly linked to – democratizing political and economic power.

Things however may be more complex. Traditional visions of facts and appeals to sound science are only part of the story. The other is a novel wave of techno-science represented by gene technologies, nanotechnologies and the "converging technologies" narrative[7]; a wave largely overlapping with, and affected by, the raise and spread of neo-liberalism. A major mismatch between social science accounts of techno-science and the neo-liberal narrative, regulations and practices stems as a consequence. For the former, as we have seen, acknowledging the unstable, manufactured character of the biophysical world entails acknowledging that the possibilities of "manipulating" it, in the sense of a full control of the emerging "objects", are limited, and always risky – actually, the more we intermingle with them, the more limited and risky they become. The neo-liberal framework also assumes that knowing means making; yet from this premise it draws an opposing conclusion: thanks to the manufactured character of biophysical reality human agency expands – in a proprietary, acquisitive sense – to unprecedented levels.

[7] The latter refers to the synergistic combination of bio, nano, informational and cognitive techno-sciences, allegedly leading to a "tremendous improvement in human abilities, societal outcomes, the nation's productivity, and the quality of life" [43, p. ix].

Gene technology regulation offers the best example of that. Notoriously, the extension to the living world of the patenting rules for industrial inventions represents a crucial passage. The details of this story have been told many times, so I can focus here on a few points. The basic justification of biotech patents is straightforwardly modern: innovation is beneficial to the whole society, and patents are the best way to promote and spread it. The grounds of the extension, however, are far from obvious. Actually, they needed time and effort to be carved out, between the late 1970s and the 1990s, through regulation and judicial review. In synthesis the grounds are: a) a mechanistic conception of the world (i.e. organic and inorganic matter are understood as an assembly of parts); b) isolation and purification as criteria for distinguishing what is manufactured from what is not; c) dematerialization of physical matter into its informational contents, that is pure function [53]. A living entity, in other words, is considered an "artefact" if its basic functional parameters can be controlled, and thus reproduced. Along this line a divide can be made between nature and manufacture, discovery and invention. Manufacture, that is contingency, is therefore equated to control. The more unstable the world is, the more manageable it is.

Moreover, "those who have *legitimate* research interests in their use and *presumably possess the capability* to perform sophisticated scientific studies" [37, p. 59, italics added] are granted access to the "necessary raw materials"[8] of any type, including human biological matter; and manufacture is presumed by virtue of the very demand for a patent [53] – it is the denying authority that must prove that something "exists in nature". In this way formal records in science and business, validated by public authorities such as patenting offices and courts, entitle some actors to decide upon respect of individual privacy and access to functional capacities interpreted as relevant information, that is tools for control; to decide if something is the property of specific human beings or of themselves, as allegedly working for the common good; if something is a product of "nature" or of human craftsmanship; if it does, or does not, belong to the provisional, ill-clarified, non-domesticated world lying beyond the current boundaries of commodification.

Rather than declining with the decline of stability, control thus expands with contingency. At the same time the manufactured character of the world entails no need to ground action on agreed visions of the common good. As much room as possible is instead to be given to those able to carve out extending areas of manageability of biophysical processes. Building on their capacity such actors are able to set, case by case, the division line between what is manufactured (thus a matter of manageable contingency) and what is not (thus a matter of negligible indeterminacy, since for the moment it is beyond any purpose).

Biotech regulation can therefore be regarded as a full-fledged incarnation of the neo-liberal narrative of agency, where uncertainty entails an increase, rather than a decrease, in the capacity of control, within the limits of the manufactured world of course. Yet such limits define also the limits of meaning, the limits of the salient world. According to Schmitt [48] sovereignty consists in the capacity to decide upon the exception to the rule, that is to redefine the existing order, to establish a new one. In the biotech field the production of knowledge creates that very state of exception, where entities are allocated to nature or manufacture according to sovereign decisions. Nature, more accurately, is redefined each time as the provisional, blurry, non-domesticated world lying beyond the boundaries of commodification,

[8] Cf. the following statement: 'Yet one earnestly wish to protect privacy and dignity without accepting (...) that the interference with those interests amounts to a conversion of personal property. Nor is it necessary to force the round pegs of "privacy" and "dignity" into the square hole of "property" in order to protect the patients, since the fiduciary-duty and informed-consent theory protect these interests directly by requiring full disclosure. (...) The extension of conversion law into this area will hinder research by restricting access to the necessary raw materials' [US Supreme Court, *Moore v. Regents of University of California*, 51 Cal. 3d (1990) at 140: 144-145].

as set by commodity producers; in actual fact it is a "commodity-in-the-making". Commodity producers, thus, are basically rulers onto themselves, so they are at the same time responsible and irresponsible towards anyone for their own choices. Hobbes's Leviathan, we may recall, expresses the will of individuals who submitted themselves to his own will. Subjected to him, they are subjected to themselves; thus he is fully accountable to them, yet accounts are neither necessary nor due. A similar "responsible irresponsibility" (or vice versa) is produced by the grounding assumptions of the patent system: generalized beneficial outcomes of innovation; ability of legitimized actors to accede to biological "raw materials"; inverted burden of proof on the manufactured character of living beings.

There is more here than Ulrich Beck's notion of "organized irresponsibility" [1], which refers to a growing difficulty in specifying liabilities (despite an expanding regulation), because of conflicts over hazard description, relevant knowledge, sufficiency of evidence, legitimacy of monitoring and sanctioning. The peculiar account of contingency provided by the biotech regulation opens the way to alternate appeals to the ethics of responsibility and the ethics of principles, with major exonerating effects. On one side a manufactured world is suitable for liability rules. This hampers any claim for responsibility beyond established causal connections, the ascertainment of which is however likely to grow harder the more intricate and privatized the fields of inquiry become[9]. At the same time, the sliding borders of commodification allow for any surprise to be accounted for in terms of a blow of the blurry, indistinct, wild world waiting for (and always close to!) domestication; a price worth paying – also for those who pay it, since they too will enjoy the benefits of innovation.

In itself the exonerating combination of the appeal to the two ethics is not new, being found in various regulations. An example is a recent European Union's directive according to which environmental liability is applicable only "where it is possible to establish a causal link" [9, § 2.6] between activities and damages, while at the same time lack of societal insight, understood as "the state of scientific and technical knowledge at the time when the activity took place" [9, § 8.4(b)], is regarded as an exonerating clause in front of ascertained causal links. Behind such formulation, however, still lies the idea of a stable world to be discovered and mastered. In a manufactured world the power of the exonerating mechanism is likely to be enhanced to unprecedented levels.

Conclusion

According to Fuller, in the neo-liberal political economy nature does not represent "an ultimate irreversible barrier, [but] a constraint that can be strategically manipulated" [14, p. 2]. I would go further: biotechnology regulation, and even more the narrative of converging technologies, depict the biophysical (and biopsychical) world as inherently plastic and open to commodification. Uncertainty appears manufactured in a thicker sense than it is usually understood [1]. It does not stem from the broadening scope of human intermingling with materiality, but from the broadening capacity to craft the latter, to make it while appraising it, to shape the contingency one is confronted with. Blurring the distinction between subject and object in a context dominated by the discursive and regulatory expansion of individual,

[9] An extension of strict liability could partially answer the problem. The latter applies whenever considerations of burden distribution prevail over considerations of individual fault; whenever it is deemed preferable to hold liable those, for example entrepreneurs, who are able to anticipate, calculate and budget (usually through insurance) for the consequences of events independent of their own fault, but occurring within their organizational sphere, rather than asking the damaged subjects to proof causal connections that remain largely hidden behind the doors of such sphere. However insurance companies are notoriously reluctant to cover ill-quantifiable hazards.

economicistic subjectivity multiplies the states of exception, where even the basic distinction – which the co-production narrative does not question – between human and non human becomes blurred, negotiable, open to decision. The manufactured world of today's techno-science may look similar to the world inhabited by pre- or non-modern cultures: a world where facts and words, things and humans, interweave in a tight, intimate way [29]. The crucial difference, however, is the presence of the modern (especially neo-liberal) agent, who manufactures manageable contingencies – manageable precisely because their features are carefully, competently manufactured. For Hobbes laws of nature and laws of society were expression of a same order. Late modern sovereigns are much more powerful than his Leviathan, since they establish the very nature to which human behaviour should conform.

The mismatch between social science discourses of co-production and neo-liberal techno-science discourses and policies depends on two conceptual moves lying behind the latter: a) the master frame of knowledge production is progressively shifted from discovery to invention; b) manufacture is equated to commodification and appropriation. The first move fits into the idiom of co-production quite well. It upholds that knowing the world merges with creating it. The second move, instead, is at odds with the inclusive, loosely communitarian, orientations of social science scholarship. This mismatch considerably affects the critical capacity of the latter, its arguments being endorsed and diverted at the same time.

As we have seen, co-production scholars argue that the search for facts and truths is inevitably mixed up with social commitments. This implies a recognition of the limits to science's predictive capacity and at the same time a plea for more inclusive policy processes. The implicit assumption is that, if the production of knowledge is increasingly crucial to political and economic power, then "democratizing" the former would crucially affect the latter in the same direction, leading to a more environmentally sustainable and socially equitable world. What is happening, however, looks to be the opposite. In the neo-liberal context the unstable, manufactured character of the biophysical world is equated to unprecedented opportunities of commodification. Moreover, on one side techno-science advancement does not seem to be reducing (many contend it is helping to enhance) economic, political and health inequalities. On the other, the drift from discovery to invention expands the proprietary character of knowledge, leading to a decrease in its openness to public scrutiny and to growing difficulties in ascribing responsibility.

Some STS scholars have actually begun to express concern for the unintended effects the narrative of the constructed character of knowledge have produced [31]. While they spent their time arguing against traditional accounts of the science-policy relationship, the line of fire was shifting to the sliding borders of discovery and invention, fact and artefact, appraisal and negotiation of nature, disabling and enabling instability. The difficulty for inclusive policy designs to overcome the traditional divide between cognitively able and disabled people overlaps with the spread of patenting as a powerful device for the private appropriation of the world. The scope of inclusive forums for deliberation shrinks not only, and possibly not so much, because of persistent appeals to hard facts as the preserve of qualified actors [21], but because of the expanding allegation that facts have a hand-built, proprietary character. Public scrutiny of knowledge production is not only, and possibly not so much, affected by the alleged limits of people's cognitive reach, as by the limits of their legal reach.

While Popper argued that science is the guarantee of an open society, the American pragmatists, perhaps more sensibly, argued that democracy guarantees science as a social enterprise aimed at producing knowledge for the common good. Thus, it is likely that politics and economy can be democratized and responsibilities rearranged not by "democratizing" knowledge production, but rather the reverse. In terms of intellectual elaboration, what is lacking today is a narrative of the relationship between society and nature that can uncouple

"manufactured" and "proprietary". Such a narrative might provide conceptual underpinnings to social forces aimed at imparting a major twist to neo-liberal society.

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