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Algorithmic Reflexivity: The Constitution of Socio-Technical Accountability in Financial Pricing

Andreas Langenohl*

Abstract: »Algorithmische Reflexivität: Die Herstellung sozio-technischer Zurechenbarkeit in der Preisbildung auf Finanzmärkten«. In ethnomethodology (EM), the concept of reflexivity refers to processes of the constitution of meaning through which actors collaboratively produce the interpretations they need in order to orient themselves in various situations. The paper discusses how EM's constitutive theoretic notion of reflexivity can be applied to non-human agency, referring to approaches in the social studies of finance (SSF) as they are informed by science and technology studies (STS), and in particular, how a reflexive notion of meaning and agency might be applied to financial agency that is largely object-driven, automated, algorithmic, and operates through quantifiers (that is, prices). Filling this gap, the paper outlines how meaning making in largely automated and algorithmic financial markets can be conceptualized in terms of EM's notion of reflexivity. It thereby refers to recent conceptualization of algorithmic action as a social logic centering on the execution of prescriptions, connects this conceptualization to EM's notion of accountability, and reconstructs algorithmic finance as a particular distribution of accountability and constitution of reflexivity, among human and non-human financial agencies.

Keywords: Reflexivity, accountability, ethnomethodology, algorithms, pricing, social study of finance, financial markets.

1. Introduction

This paper intends to review, and to revive, a discussion about the category of reflexivity in science and technology studies (STS) that was held around 30 years ago and was then rather rapidly and inconclusively shelved (Langenohl 2009a, 2009b). Those of its protagonists who argued for a strong notion of reflexivity, and in that relied to some degree on ethnomethodology's (EM) constitutive-theoretic notion of reflexivity, steered the debate into a dead end where STS found itself busy more with itself than with its object of analysis,

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that is, science and technology. At least, this is how that debate has been characterized recently:

Their [the “reflexivists”] aim was to shatter the reader’s supposed “naive belief” in the text and make her aware of the text’s artificial nature by constructing it so that it more or less deconstructs itself. As a result the text becomes more of an epistemological project directed to question our alleged epistemological habits (i.e. naïve realism) than any scientific representation of the empirical subjects studied. [...] No wonder, then, that the reflexivist programme never took off in science and technology studies: readers were still more interested in the news about laboratories. (Knuuttila 2014, 303)

In contrast to this view, I contend that this debate regains importance in the present day. As it referred to ethnomethodology’s notion of reflexivity at least marginally, it introduced the crucial question of the attribution of *accountability* into the debate, that is, of a concept that investigates the ways that social actors attribute each other proper conduct in a given social situation. Today, this question is more important than ever, especially for STS, as according to many accounts technology increasingly assumes the capacity of *autonomous* agency, which raises the question of how that technology might be held accountable for what it does (Walters 2014; Rauer 2016).

In short, then, this paper addresses the question of whether and how EM’s notion of reflexivity might be deployed in order to understand the agency of things, and it does so with respect to an area of research that has emanated from STS, namely, the social study of finance (SSF). It will be argued that financial markets display a genuine *technical* dimension through the ways that they institutionalize economic coordination as algorithmic agency, namely, through the mechanism of pricing on the grounds of the relationship between supply of and demand for financial securities. By dint of this mechanic quality of pricing, financial markets have been algorithmic way before today’s computerized algorithmic trading. And the question is, then, how prices might be *reflexive*, that is, held accountable for what they do.

The paper proceeds as follows. First, it gives an overview over EM’s discussions about the notion of reflexivity as a constitutive-theoretic concept, focusing in particular on the relationship between reflexivity, accountability, and what will be argued is a minimalist notion of acting subject in EM. Second, the paper reconstructs how EM has been received and discussed in STS and its predecessor, the sociology of scientific knowledge (SSK). The paper’s main section will first reconstruct how STS impacted a particular social scientific way of analyzing the financial economy, which is SSF, in order then to demonstrate that the manifestation of “science and technology” in financial markets regards first of all the calculative operation of pricing. The section then continues to view pricing as an algorithmic procedure, thus opening up the question – mainly discussed along the lines of recent work by Valentin Rauer (2016, 2019) on algorithmic agency – of how algorithmic agency might

be analyzed as technical agency in terms of EM's notions of reflexivity and accountability. The last section concludes and makes a case for an analysis of technology and object-centered sociality in terms of reflexivity-as-accountability.

2. Reflexivity in Ethnomethodology

Ethnomethodology is at its root a theory of social order that parts with assumptions about societal structures organized at some macro-level of society. Instead, it maintains that social order is produced in situations of social interaction, and that any understanding of social norms and rules carried into that situation by its participants requires interactional confirmation and verification in order to become effective as ordering devices (Garfinkel 1967b). Most fundamentally, participants are included into social situations by being attributed by other participants the quality of performing in an “accountable” manner (Garfinkel 1967a, 33). This means that their way of behaving and interacting with others must be communicatively affirmed by those others as orderly, appropriate, and *normal* for them to perform as fully legitimated members of the social group assembled in the interaction. Crucially, this happens not through explicit verification but through communicative mechanisms that usually go unnoticed and can be analyzed according to the formal ways that they organize relationships in the interaction. The successful and effective attribution of accountability through such mechanisms is the prerequisite for an interaction to be perceived by all participants as “normal” and “proper.”

The way that participants refer to their understandings of rules and norms that ought to govern a situation and the communicative procedures that affirm and effect those rules and norms is thus circular or recursive. This recursivity between preconceived norms and communicative mechanisms to validate and enforce them is termed *reflexivity* in EM (cf. Mehan and Wood 1975). Reflexivity is thus a concept that highlights the ultimate groundlessness of social order outside concrete situations in which those rules and norms that members hold to be important are actually affirmed and verified through the mutual attribution of accountability.

This situationist theory of social order has important consequences for the conception of agency. Social actors figure predominantly as “members” (Garfinkel 1967a, 32), that is, as social entities defined through their attribution to a social group that seemingly shares the same understandings of any given situation. However, for EM, a situation does not require a substantial identity or even overlap in its members' understandings, orientations, attitudes, or whatever else they might bring into the situation as *subjects*. This is the case because the rules and norms that govern the situation can become effective

only through interactional methods that affirm and effect a certain definition of the situation without being substantially linked to any subjective understandings, beliefs, and so on. In other words, the methods of interaction and interrelation that install a certain situational definition as *given* are far more important than what the participants subjectively see in them (Garfinkel 1967a, 33-4). An instance for this are reparative mechanisms, which Garfinkel (1967b, 42-9) analyzed through “breaching experiments,” that allow for maintaining accountability attributions even to participants whose actions ostensibly contradict the shared situational definition.

From this it follows that EM maintains a radically minimalist notion of agency – minimalist in terms of the presuppositions made regarding the subjectivity of the actors. As the methods of arriving at a shared situational definition operate not only independently of, but at times against, subjective understandings, beliefs, and interests, accountability is not attributed on the basis of a foundational, essential subjectivity – rather, subjectivity is an effect of the attribution of accountability. Within this paradigm, accountability might as well be attributed to carriers of agency that are not human, for instance to animals, plants, or technological devices. It is thus no surprise that EM has provided a fertile ground on which to grow some theoretical generalizations in STS, for instance, actant network theory (ANT). The next section will thus reconstruct and decipher the impact of EM on STS.

3. Selective Readings of Ethnomethodology in Science and Technology Studies and Actant Network Theory

STS, and its predecessor discourse known as the sociology of scientific knowledge (SSK), has not been a unitary paradigm but a field of research with rather different points on entry into the investigation of how scientific knowledge gets produced (cf. Ashmore 1989, for a, if playful, mapping of the field in the late 1980s). As such, it has referred to EM in some of its research. Researchers like David Bloor, the promoter of the *strong program*, have tended to attribute the production of scientific knowledge to the (class) interests of scientists, and were not particularly interested in the ramifications of scientific interactions or socio-technological processes. The latter was, on the contrary, the predominant interest of laboratory studies, which viewed the scientific lab as the production site of scientific knowledge, yet less in a Marxian idiom and more with a view to the microstructures of knowledge-producing processes and interactions. Approaches in laboratory studies therefore preferred ethnographic and process-analytical methods that were closer to EM. Some former SSK researchers deliberately refer to central

ethnomethodological conceptions, like accountability. According to Karin Knorr Cetina (Knorr Cetina, Krämer, and Salomon 2019, paragraph 8), Garfinkelian accountability has figured centrally in SSK and STS both with respect to the sociological training that early science studies scholars received (and to the engagement of Garfinkel in science studies, see for instance Lynch, Livingston, and Garfinkel 1983) and to the understanding, attributed to Garfinkel, that in order to do an ethnomethodological analysis one must acquaint oneself with the reality segment one sets out to investigate. However, the references to EM in SSK were neither very widespread nor uncontroversial, and this had to do less with the category of accountability than with that of reflexivity.

At the beginning of the 1980s, a debate in SSK unfolded after an intervention by Steve Woolgar (1988) in which he referred to EM in order to argue that the constructivist impulse of SSK ought to be applied not only to the natural sciences and the processes in laboratories, but also to SSK itself. In particular, he argued that any scientific statement presents a version of reality that is embedded into sensemaking practices which follow the communicative and rationalizing mechanisms that EM had argued lay at the foundations of social order: “The artful concealment to which I refer is to be understood as symptomatic of *all* explanatory practice, not as reflection of the motives of particular individuals. So I make no apology for pointing out the significant sense in which *all* such work is *essentially flawed*” (Woolgar 1981, 511; emphasis in the original; quoted after Knuuttila 2014, 301). In other words, scientific reality – including SSK’s reality – was to be subjected to the same sensemaking and stabilization routines as everyday interactions. In this, Woolgar could refer to EM’s account of scientific knowledge production as being a specific instance of producing accounts of reality that rested on the production of “vernacularly accountable ‘ties’ between a sequence of practical actions in the lab and concretely visible features” of a research object in a given experimental order (Lynch, Livingstone, and Garfinkel 1983, 224). This in turn referred crucially to the somehow ambivalent ethnomethodological theorization of reflexivity by Mehan and Wood (1975) as lying at the ground of any account, including EM’s own accounts. In other words, Mehan and Wood provided a platform from which to view the category of reflexivity as universal and at the same time as radically relativistic. Building on this debate, Malcolm Ashmore (1989) attempted to rework this seeming paradox of a universalist category which relativizes any universalist account into a program of reflexivity-oriented SSK, experimenting with innovative styles of academic writing (or “wrighting,” as he put it) that (not unlike in the “writing culture” debate, cf. Clifford 1988; Clifford and Marcus 1986) sought to present different voices and accounts that pragmatically accumulated to a multiplex narrative of SSK’s practice.

The debates that these interventions triggered have been described in greater detail elsewhere (Hands 2002; Langenohl 2009a, 2009b). As Knuuttila (2014, 303-4) points out, they were rather short lived, as from the early 1990s on SSK/STS researchers presented their analyses and theorization increasingly in a somewhat more traditional way, namely, either through objectifying the exact sciences in the same way those objectified nature or, on the contrary, through reworking STS into a philosophy that tried to escape the juxtaposition of objectivity and subjectivity and of realism and constructivism (Latour 1999). While the former strategy silently did away with reflexivity as a problem of STS, the latter explicitly rejected reflexivity as being part of a grand scientific constellation in which the problem of reflexivity figured as a derivation from the underlying conundrum that humanist versions of science had long opted for separating the business of science from a world that always threatened to pollute it. In *Pandora's Hope* (1999), Bruno Latour explicitly denounced reflexivity as being part of a postmodern escapist strategy that claimed to undo the truth claims it attributed to modernity, while in actuality continuing the “modernist settlement” that sought to radically disentangle the world to be known from the knowing subject. It is difficult to tell whether his assessment of “reflexivity” as being in a state of “over-emphasis,” coming along with “maddening efforts to write texts that do not carry any risk of presence” (Latour 1999, 22), makes direct reference to Ashmore’s (1989) *Reflexive Thesis* or whether it merely tries to portray what Latour perceived to be a post-modern trend in general (among which his text also counts Derrida’s deconstruction and Lyotard’s “debunking of ‘master narratives,’” *ibid.*, 21). Yet it is clear that Latour in this monograph, dedicated like none of his other works to issues of epistemology, dismisses reflexivity as a sham problem.

At first glance, it is stunning that Latour reproaches the notion of reflexivity as incarnating a problematic that can only be one on the basis of a dichotomy of objectivity and subjectivity and that he categorizes reflexivity on the subjective side of the epistemological cleavage he wants to undo, given that reflexivity was introduced into EM with an outspokenly *weak* notion of subjectivity in its arsenal. Yet upon closer observation, this subjectivist rearticulation of reflexivity was perhaps a necessary outcome not only of his endeavor to account for non-humans in his philosophy, but also of the ways that reflexivity had been debated in SSK: namely, as a problem that pertains to, as Woolgar had put it, all “attempts at explanation” (Woolgar 1981, 511; quoted after Knuuttila 2014, 301), and from which Ashmore (1988, 1989) accordingly had sought a way out through new kinds of representation, that is, novel ways of academic writing. In fact, Woolgar, Ashmore, and Latour effectively subscribe to *a notion of reflexivity that poses a problem of subjectivism*. Thus, the discussion about reflexivity in STS (and not only there) has inclined toward a notion of reflexivity that is based on a strong concept of subject – not least made clear through Latour’s remark that associates reflexivity with

an ultra-postmodern conception which effectively writes forth the modernist settlement which separates subjectivity from objectivity.

In contrast to this, and as argued above, the notion of reflexivity in EM has been introduced into social analysis on the basis of an extremely minimalist notion of subjectivity. For EM, subjectivity is something which always appears only as a result of processes of attribution and description that are not constitutively carried by subjects but rather operate through them in the form of methods of interrelating participants that can be formally described. Correspondingly, the notion of accountability is not to be seen as something that constitutes subjectivity but rather as the product of certain methods of accomplishing it. That is, if accountability is applied to a subject in the sense of a human actor, this is no anthropological universal principle (and also not an instance of a modernist settlement) but a quite particular product of a quite particular set of rules to determine accountability. In principle, nothing speaks against theorizing a kind of accountability that can also be applied to non-humans, like machines, animals, plants, or stones – practices that human participants in interactions are all too familiar with as they curse at computers, talk with their pets and flowers, and meditate upon architectural achievements. Actually, it might have been expected from STS and ANT to develop this kind of application of reflexivity and accountability to non-human entities. However, as far as I can see, this has not happened.

4. The Potentials of an Ethnomethodology Notion of Reflexivity for the Social Study of Finance

4.1 Science and Technology Studies and the Social Study of Finance

Science and technology studies has had a decisive impact on the ways that the social sciences understand the economy, thereby especially the financial economy. In contrast to international political economy, which highlights the ways that financial markets are part of the entire economy and how they relate (or not) to the production-based economy (Strange 1986; Castells 1996; Davis 2009), SSF rather views the financial economy as a socio-technical arrangement, or set of arrangements, in which agency is complexly distributed over human actors, calculative devices, and socio-technical and legal units and infrastructures (Callon and Millo 2007; MacKenzie 2008). Like STS does with respect to (still mostly natural) science and technology, SSF claims to denaturalize the seemingly *normal* working of financial operations, placing the emphasis on the complicated and quite presuppositional interactions between human and non-human actors and infrastructures in attaining the

seeming smoothness of financial processes (Knorr Cetina and Bruegger 2000, 2002). While it may be argued that SSF pays too little attention to the genuinely economic dimension of financial markets through deemphasizing patterns of profit making, distribution, and overall political-economic structures, it has decisively contributed to demonstrating how the financial economy is *embedded* in, and rests on, social and technical procedures that are not *economic* per se, thus challenging economic and especially neoclassical accounts of the *market* as a thing governed by seemingly natural (that is: universal, non-social) laws.

In this regard, SSF has been particularly strong in denaturalizing the price mechanism in financial markets, which is not only the core both of neoclassical economics and of the more recent discipline of finance but has also served both to claim for themselves the dignity of an exact – read: mathematical – science. While both neoclassical economics and finance conceive of the price as a signal that naturally and automatically emerges from interrelating a given demand with a given supply in a given commodity (or security) and is subject to mathematical laws and no others, SSF has demonstrated that “[t]he price is a social thing” (Beunza, Hardie, and MacKenzie 2006; cf. also Hardie 2004). Far from mathematical reductionism, financial pricing presupposes the existence of calculative norms, orders of comparison, and institutions that allow pricing in the first place to be effected on the ground of the relationship between supply and demand. Financial markets are institutionalized in a way that differs from other markets, as analyzed by economic sociology (cf. Fligstein 2001): financial institutions (Sassen 1991, 2005), legal norms pertaining to finance (Riles 2011), and the components of calculation (for instance, various components of risk, cf. Langenohl 2018) are assembled in a way to attain an almost purely mathematical pricing mechanism. In other words, if mathematical pricing is at the core of the ways that financial products attain their economic value, it is not because they materialize a universal economic law but because finance is *socially and institutionally arranged* so that prices may form according to mathematical calculation (MacKenzie and Millo 2003).

Seen from this angle, much of the recent discussion about *algorithmic finance* misses out on the fundamental significance of the fact that financial markets have been operating algorithmically long before the advent of computerized trading. Inasmuch as pricing was institutionally enabled and allowed to solely rely on the mechanical interrelation between demand and supply, and on that basis to unfold its effects and economic significance, the financial economy was algorithmic all along. For achieving this quality, it is of only secondary importance if the calculation is accomplished by humans, by pocket calculators, or by so-called learning algorithms. Thus, although it is true that the computerization of finance since the 1970s enabled a calculative leap in the design, production, and interrelation of financial products

(among them crucially, derivatives) that some observers regard as a qualitative difference to the prior state of affairs (MacKenzie and Millo 2003), computerization, automatization, and algorithmicization are conceivable only on the condition that the processes thus computerized have already been institutionally brought into a calculative shape – a process that Callon (1998) refers to as *framing*.

The existence of SSF itself testifies to this seemingly qualitative leap in finance, which is the effect of technical innovation yet at the same time a continuation of finance's characteristics before the invention of the electronic computer, in a complex way. On the one hand, SSF puts the emphasis on the socio-technical institutionalization and operation of financial markets, thus demonstrating how finance acquires rhythms and dynamics of its own that cannot be explained by any neoclassical market functionalism (Clark and Thrift 2005). On the other hand, as SSF singles out pricing as the core operation of financial markets, it reconstructs the *agency* of prices – that is, the effects of entities whose seeming autonomy emerges from socio-technical and legal calculative devices – as being decisive for finance in its quality of being different from the rest of the economy. However, what threatens to go amiss in these reconstructions of socio-technical devices that enable mathematical pricing is the mentioned circumstance that the *technicality* of pricing resides not in any particular technology, but in the purification of calculative routines that can, in principle, be achieved without high-end technologies. If the financial price is a *social* thing because the preconditions of its mathematical constitution have to be socially and institutionally arranged (Beunza, Hardie, and MacKenzie 2006), then it *remains* social even under conditions of technical algorithmicization. Differently put, the algorithmic quality of prices can be attained through various socio-technical constellations, not only high-end computerized trading.

To come back to this article's agenda: If we want to apply the category of accountability to science and technology, the case of financial market pricing reminds us that technicality must be distinguished from concrete technologies. In the case of finance, then, its algorithmic character is not inscribed only into computerized technology but is the effect of a form of institutionalization that has more than one possible socio-technological manifestation. Thus, the question of accountability ought not to be addressed to concrete technological devices but to their calculative effect: financial price. So, then, how can financial prices be analytically rendered in terms of accountability and reflexivity?

4.2 Algorithmic Agency: The Accountability of Prescriptions

In order to address this question, it is helpful to first turn to recent work that attempts to circumscribe the operation of algorithms from a social theoretical

viewpoint. In particular, I will draw on theoretical and empirical work by Valentin Rauer (2016, 2019), who has investigated debates and conflicts around the accountability of algorithm-powered technologies such as drone vehicles and internet search engines. For Rauer, the notion of algorithm promises a more fruitful and precise point of entry into contemporary diagnosis regarding the rising influence of new technologies, which are usually captured by notions such as digitalization, artificial intelligence, and others that rely on a juxtaposition with a respective opposite, which is however only seldom spelled out. In contrast to this, the notion of algorithm, or *algorithmic action*, has the advantage of not conflating a conceptual device with a contemporary diagnosis – the notion on algorithm is much older than the new technologies of the present. So, rather than speculating about the newness of the effects of algorithms, the author addresses the question of what algorithms do in terms of classical sociological theories of action. According to his reconstruction, the agency of algorithms can be aligned with actions that people perform when *executing instructions (Vorschriften)* – that is, rules which aim at solving very particular problems through following sequences of action that are prescribed in a detailed manner.

Rauer argues that sociological theory has tended to marginalize this type of action, which may have to do with the fact that instructions differ from other social norms in one crucial aspect. While the validity structure of social norms is usually conceptualized through the existence of negative sanction, the concept of instruction can do without that notion: if one does not follow the instructions of a computer manual, one is not *sanctioned* but simply will not be able to operate the computer. Moreover, instructions also differ from teleological, or instrumental, action because their protocols do not refer to a state of affairs attributed with any particular desirability or worth. Rather, instructions come closest to the notion of agency as described in ANT, namely, the sheer effecting of certain results. However, Rauer goes beyond this reductionist notion of action in his conceptualization of algorithmic actions; and as I will argue, it is here that the problem of reflexivity and accountability in STS and SSF can be transformed into a research agenda.

First, Rauer argues that certain traditions in social thought have, for a long time, implicitly argued that human action can be conceptualized along the lines of algorithmic action, understood as the execution of instructions. According to Rauer, this applies to Gabriel Tarde's (1903) notion of *imitation*, yet also to rational choice-oriented decision theories: actions can be conceived of as being direct and foreseeable responses to environmental influences. What is particularly interesting in these reconstructions is that Rauer highlights that instructions are not always self-contained and fixed but can be flexibly referred to others' perceived actions. This is the case in Tarde's notion of imitation, which conceives of action as the emulation of perceived patterns in others' actions but also in decision theoretic and especially game theoretic

conceptualizations (as Axelrod's famous "tit for tat" yet also nuclear strategies, cf. Amadae 2015), where actors can be *programmed* so as to act in a certain way in case of a certain perceived behavior of their interactants. This discussion sets the stage for an understanding of algorithmic action as programmed action that is still responsive to its environment.

Second, Rauer expands this theorization through a discussion of Jürgen Habermas's ideal-typical categorization of actions, which groups actions according to their quality as being social versus non-social and being oriented toward mutual understanding (*verständigungsorientiert*; Habermas 1987, 76) versus being instrumental. Rauer observes that within the resulting two-by-two matrix, one field remains conspicuously empty: that of non-social (or *interobjective*) action oriented toward mutual understanding. Rauer takes this lacuna not so much as a fault in Habermas's theory but rather as an invitation to discuss the propensities and capacities of algorithmic action to be oriented toward understanding. On the one hand, current "learning" algorithmic devices as in computer search engines or automated vehicles (and, as I would add, financial trading algorithms) clearly display an orientation toward "understanding" actual or potential interactants – for instance, reconstructing a consumption profile from a user's navigation through the internet or predicting price movements in financial markets through anticipating other traders' actions. In other words, algorithmic action can be oriented toward anticipating others' actions, and in *that* sense attain an understanding of those actions. On the other hand, if compared to inter-human interaction, algorithmic action appears as deficient because, as Rauer argues, algorithms cannot be held responsible and accountable for what they do in the same sense that humans can be held responsible and accountable. Related to that, algorithms cannot give justifications for their actions. Rauer concludes his theoretical discussion on the argument that the capacity of algorithmic action to achieve an understanding of the other without being liable for the actions that result from that understanding is at the core of today's conundrum concerning artificial intelligence. Algorithms appear to be autonomous as their programming equips them with the ability of complex and differentiated orientation at understanding (that is, anticipating) the other; yet at the same time neither they themselves nor their programmers, who are outsmarted by their creatures' complexity, can give reasons, let alone justify, every single move of an algorithmically powered device. Accordingly, what ensues is public debates and negotiations about the distributed agency and responsibility of assemblages of human and non-human, algorithmic action (see Rauer 2016 for a discussion of public debates about military airborne drone activities; cf. Walters 2014).

In order to bring Rauer's discussion of algorithmic agency into the horizon of ethnomethodology's notion of reflexivity, I propose one modification and one extension of his argument. First, the modification: While the reference

to Habermas enables Rauer to point out the *other*-orientation of algorithmic action together with its accountability deficit, I contend that in order to conceptualize the accountability of technology, it is more helpful to turn to EM's notion of accountability. Habermas's notion of "communicative action" integrates conceptual elements of accountability and responsibility into itself by dint of an argument that in the last instance is a moral theoretic one and presupposes a strong notion of subjectivity: namely, a subject that is in principle capable of critically addressing his or her own motivations, convictions, interests, and aims (Habermas 1987, 73-6). It is evident that this moral dimension of action must be absent from algorithmic action, which operates without any consideration of motivation, interest, or aims. However, EM's minimalist notion of subjectivity, informing its conception of reflexivity and accountability, can be more easily brought together with algorithmic action, because the recognition and attribution of accountability in a given interaction is based on a cognitive procedure (the "routine grounds of everyday activities," Garfinkel 1967b), not a moral capacity. To be sure: EM does allow for morality as a communicative register to emerge in situations, for instance, on the occasion of interactional repair mechanisms, when the failure to attain accountability might be attributed to an interactant's inferior morality (as has been noted by Garfinkel 1967b). Yet even so, morality is a *device* in the service of the *procedural* establishment of accountability, not a *substantive* and subjective *source* of it.

Second, the extension: Ethnomethodological work on the sequential operation of prescriptions has argued that no prescription is ever as complete as to make redundant the work of situational adaptation of the prescriptions to concrete, embodied, and material settings of action. On the example of conducting natural-scientific experiments in laboratories and replicating their results in the classroom, Lynch, Livingston and Garfinkel (1983, 209-12 *et passim*) have argued that the prescriptions to set in motion an experiment cannot account for its situational contingencies, like, for instance, the spatial positions of experimenters, instruments and epistemic objects. Instead, it is a matter of situational interpretation as the experiment unfolds which particular frame conditions can be counted among the prescribed setting and which ones have to be counted as aberrations (see also Suchman 2007). Seen from this angle, prescriptions form a reference point for an accountability operation through which the result of a certain sequence of actions that is carried out using prescriptions is attributed to those prescriptions having "led to" the result (or not, in the case, for instance, of scientific artifacts which are attributed to a less-than-optimal execution of prescriptions or a less-than-optimal research setting). Following prescriptions does not guarantee accountability per se, but instead triggers complex socio-technical operations whose perceived result can always be questioned regarding their precise causal interconnection between the prescription (or the *program*), the sequence of

actions it informs, and the result. In fact, this is what, according to Rauer, constitutes contemporary debates about *autonomous* algorithms, whose actions are programmed yet whose effects cannot always be evidently traced back to the programming. Thus, Rauer's notion of prescription-based action ought to be ethnomethodologically grounded: Algorithmic action enters the play of distributing accountability not in any unproblematic manner, but as a component in a complex web of human and non-human accountability attributions. It is precisely the principally contested character of algorithmic actions – and vice versa, the accountability trials to which algorithms put human actions (see below) – that highlights the eligibility of algorithmic action for a theorization based on EM's notions of accountability and reflexivity.

To sum up this subsection, accountability is a crucial component of EM, being entangled with its notion of reflexivity, because social actors collaboratively set the stage for interactions through attributions and signaling of accountability. Yet, these attributions form no universal condition but an empirical one in which accountability is withheld from actors deemed as non-human. It is thinkable that actors in situations (including highly technologized “synthetic situations,” Knorr Cetina 2009) attribute accountability to non-humans and seek for signals of their accountability to act as usual. Under these auspices, non-humans will be part of the reflexivity of a social situation. As algorithms can be seen as actants executing orders, they might in fact very well be held accountable for doing what they are supposed to do, even if no Habermasian “action oriented to reach understanding” (Habermas 1987, 76) in non-humans is theoretically conceivable so far. Conversely, non-human actants might be programmed to attribute and interrogate accountability vis-à-vis humans and non-humans, for instance, through cyber security checks (like malware detection) or through learning software that screens and addresses its users as to potential conditions of psychic abnormality (Muller and Senft 2019). Algorithmic action thus cannot only be held accountable in the EM sense, but also distribute, as well as withhold, attributions of accountability. The fact that algorithmic action, as an automated modality of action that executes prescriptions, does not guarantee accountability per se but instead invokes it in vernacular problematizations further testifies to the robustness of this theorization of algorithmic action in terms of accountability and reflexivity. Coming back to the SSF, the question is how financial prices are held and made accountable and how they, in turn, distribute accountability.

4.3 The Accountability and Reflexivity of Pricing

As stated, not only SSF, but also neoclassical economics and finance sees pricing routines as the operative core of financial markets. It can therefore be expected that the price signal, as it displays itself on the stock market ticker

or the trading screen, is part of a dynamics of the distribution of accountability among actors in socio-technologically facilitated situations. In this section I want to review the literature on trading and pricing available in SSF with respect to that hypothesis.

First, studies carried out by Karin Knorr Cetina and Urs Bruegger (2002) on over-the-counter trading, taking place directly between traders and without the intermediation of a market platform, can assume the typical distribution of accountability among human interactants as observed by EM. For instance, traders might communicate to each other information about stock market developments that are not essentially required to make a deal or expect from each other to enter into deals even if these are not immediately profitable. Traders thus signal their availability for mutuality and reciprocity beyond a strict economic and utilitarian understanding – an availability that can be forcefully demanded if not conveyed. This example merely illustrates the operation of accountability procedures even in situations which might be held to be characterized by economic instrumentalism only.

Second, however, prices can crucially intervene into the distribution of accountability in trading situations. For instance, prices and traders *exchange* accountability on occasions of unusual turmoil in the market. SSF research has demonstrated that traders react to sudden, unexpected or fatal price movements in markets in a bodily register, both when narrating those situations to the interviewer (“I got shafted, I got bent over, I got blown up,” and so on; Knorr Cetina and Bruegger 2002, 176) and when performing in such situations, as shown by the exclamations and sudden bodily activities on traders facing a drastic drop in prices (Laube 2017). In terms of the distribution of accountability, I would argue that these reactions both work toward attributing prices accountability even as they “misbehave” as well as toward maintaining an image of the professional trader by way of inversion. On the one hand, the accountability of the price is guaranteed or saved through a communicative and affective mechanism that uses the trader’s body and psychic dynamism as a valve for the turbulence. In contrast to Garfinkel’s (1967b) breaching experiments, trading subjects tend not to attribute the disorder to the other actant (which in this case is the price) but to themselves, as they demonstrate that they are on the verge of collapsing under the stress. Yet, it is precisely these emotional outbursts that safeguard the normalcy of the situation as *financial* situation because the disruptive dynamic is clearly localized in the trader’s body (and by extrapolation, psyche) and *not* in the market embodied in the price. The price mechanism is attributed the accountability of being a neutral algorithm and doing “its job” through shifting the situational breach over to the responsibility of the traders’ psyches and bodies. At the same time, the exclamations and movements can also be varied, nuanced, and subjected to attempts to control them, so as to interrelate them with financial professional accountability as “hyperrationality” (Abolafia 1996),

surfacing as coolness. Thus, while the bodily register of the traders' reactions to financial turmoil attributes accountability to the price (something is wrong not with the price, but with the traders), the price signal also attributes professional accountability to those traders who are able to remain rational and cool, thus co-constituting a professional hierarchy.

Third, algorithmic trading provides some robust evidence of accountability in the ethnomethodological sense that is distributed "interobjectively" (Latour 1996), that is, solely between and among algorithmic devices. To start with, the seemingly trivial fact that prices effect other prices is a kind of systematically guaranteed accountability of the rule conformity of prices. As they trigger further actions in the markets (trades), prices are confirmed in their adequate role not only to *reflect* a certain economic value but to *transform, inform, and effect* it (cf. Luhmann 1988). In other words, through effecting further transactions, prices become accountable as financially *significant* – a point that becomes evident on the case of the breaching experiment of liquidity stalls, when trade stops and prices cannot form anymore, and thus become delegitimized as being ineffective. This is a situation that is perfectly comparable with Garfinkel's rendition of subject's experiences during breaching experiments, such as "[a]ttempted avoidance, bewilderment, acute embarrassment, furtiveness, and above all uncertainties of these as well as uncertainties of fear, hope, and anger" (Garfinkel 1967b, 72). This interpretation reveals that the use of prices for further pricing sequences, irrespective of whether that use manifests in human or non-human algorithmic actions, is decisive for attributing accountability to the price mechanism: it confirms "price" as the always effective, and hence decisive, outcome of financial actions. Conversely, trade interruptions and pricing stalls are unproblematic for financial sensemaking as long as they can be attributed to market-external agency, for instance, operators (not traders) controlling trading algorithms or the stock market organization which may decide to interrupt trading under certain conditions (for some recent examples, see Neyret n.d.). Thus, financial pricing cannot only be traced back to the social embeddedness of calculative practices and devices (Beunza, Hardie, and MacKenzie 2006), but also invokes standards of accountability that cannot be reduced to calculative dynamics alone. The accountability of prices forms in an aura around the (principally and today also technically actually algorithmic) pricing mechanism, which is most profound in financial markets. Prices claim and attain accountability through the effectiveness with which they trigger follow-up payments and prices, with "liquidity" being that notion that amalgamates the effectiveness with the accountability of prices.

Yet, it is necessary to analytically distinguish the effectiveness dimension from the accountability dimension because it requires a specific kind of situation that enables this amalgamation. This is a kind of situation in which actants, human or not, can see only the cumulative effects of other's agencies,

and are thus unable to make any individualized accountability attributions or challenges. In other words, financial situations are strictly collective. Price, as an actant capable of accountability, can emerge only as a signal that indexes countless individual decisions to buy, sell, and hold (Langenohl 2009c, 2010). Only in the quality of invoking and “appresenting” this generality of “the market” (Knorr Cetina and Bruegger 2000, 2002), which in turn depends on the effacing of any trace of individual trading acts, can financial prices become effective, that is, trigger further transactions. It is precisely this generality that the price indexes, which is juxtaposed to the individual trading bodies, and in which both mutually attribute the other accountability as an effective price and as a (more or less) able-bodied trader. Thus, the financial price’s algorithmic agency has a double face: it executes instructions – namely, the instruction to calculate a price on the basis of countless individual acts – and it stages a generality (“the market”) which forms as the consequence of the erasure of all those countless individual acts in the price signal. It is only the combination of those two characteristics, automatization and representation, that makes financial prices able to attain accountability. If granted accountability, financial pricing is clearly reflexive: it automatically performs an instruction that produces the representation of a collectivity, which, as a motive, has entered the setting up of that instruction in the first place. Pricing produces what it presupposes.

5. Conclusion: The Accountability and Reflexivity of Things

According to EM, reflexivity operates through the invocation of patterns of normalcy through which interactions can be coordinated. Neither activity is reserved for human or inter-human agency alone. Algorithms can be addressed with accountability demands, and they themselves articulate such demands. Also, algorithms can be programmed, and program themselves, to adapt to accountability crises. A very simple, and yet striking, example is the algorithmic procedure put into operation on submission websites that demand of their users to decipher and enter a sequence of distorted characters and numerals in order to qualify as humans. The reflexivity of this “synthetic situation” (Knorr Cetina 2009), which consists of algorithms verifying humans on the basis of users executing a script (in the literal sense) that is understood to be a human activity and then in turn treated as such, directly translates into a mutual attribution of accountability: The algorithm ascribes accountability to users as human, and the users in turn ascribe accountability to the algorithm as an automated, and yet agential, security device.

Algorithmic reflexivity thus occupies a middle ground between a normative notion of accountable agency (see Rauer's discussion of Habermas in the preceding section) and the tendency in ANT and STS to reduce agency to sheer effectiveness. In contrast to Habermas, but also to purely ethical notions of reflexivity (insofar as they are decoupled from the research process as a procedure that inescapably operates with *some* notion of normalcy, usually called methodology), algorithmic reflexivity is not steered toward the articulation of critiques that address the *motivations* and *intentions* of interactants; instead, like in normal situations, they address only their *condition*. And in contrast to ANT's notion of agency-as-effectiveness, algorithmic reflexivity is situated in a processual sequence prior to and beyond the establishment of effects, namely, in the establishment of the normalcy of a given process that only after successful completion will yield effects. Otherwise, like in the "are you a human" question, further access will simply be denied. Even if falling short of a proper negative sanction in the sociological sense, granting or denying access undeniably involves a *judgmental* dimension, which, however and as stated, refers only to the attributed condition of the interactants, not on what they substantially want to do. The case of finance and of pricing is of specific interest in this regard because it makes visible how the judgmental dimension that accountability introduces into situational processes becomes amalgamated with their sheer procedural dynamics so that the judgmental attribution of the accountability of prices on display is built into that very display. As actants can see only prices as results of a cumulative processes of price formation, their sheer effectiveness leaves no option to individualize the accountability of the countless decisions that formed the price – which is exactly why the price can index a generality, called "the market," and become a factor and a force in accountability attributions.

Lastly, some thought on the earlier debate on reflexivity in SSK. As has been mentioned, that debate was polarized into two positions that together effected its inconclusive termination. On the one hand, the *reflexivists* transposed the self-referential quality of reflexivity to any scientific statement, thus making themselves vulnerable to reproaches of falling into a self-made trap, out of which they tried to climb through polyphone styles of academic writing. On the other hand, their opponents had no better arguments than to declare the whole issue of reflexivity as unimportant for SSK and STS, culminating in Latour's claim that the whole question reproduces the modernist settlement resting on a separation between object and subject of knowledge. Both parties to the debate thus stuck to a notion of reflexivity as necessarily involving *a subject making statements*. This is utterly curious in a field of research like SSK and STS, which so highlights the non-propositional agency of things. As a consequence of the discussion presented in this article, I suggest widening the notion of reflexivity to non-propositional action, like the action involved in algorithmic agency as, in Valentin Rauer's formulation, the

execution of instructions. This way, it should be possible to retain the notion of reflexivity as a constitutive-theoretic category that is not necessarily self-relativizing. The reality that prices effect through their reflexive co-constitution of accountability in financial situations does not depend on an, even hidden or pre-reflexive, agreement on any statement about that situation because this reflexivity is of a non-propositional nature. If Latour is right in demanding that science and technology should teach social scientists their sociology (“We want to learn our sociology from the scientists and we want to teach the scientists their science from our own sociology” [Latour 1988, 175]), STS might definitely learn from the algorithmic reflexivity that is far from self-defeating.

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