# Complexity and the inherent limits of explanation and prediction: Urban codes for self-organising cities

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The purpose of this article is to explore what kind of (land-use) regulation is more compatible with a radical acceptance of the idea of the complexity of socio-spatial systems and of the intrinsic limits of explanation and prediction. The article applies insights from complexity sciences to planning practice, critically comparing different land-use regulatory instruments (in particular, patterning-instruments and framework-instruments). The main result and conclusion is that it is necessary to embrace the challenge of complexity and self-organisation, and consequently to start profound revision of regulatory instruments.

**Keywords:** complexity, explanation, prediction, regulation, self-organisation

## Preface: taking complexity in a more radical way

In recent times, it has become increasingly evident that the reality in which we live is an intrinsically complex one. Social systems are among the most complex structures. Today's cities, in particular, furnish an eminently clear and particular example of this complexity (De Roo et al., 2012; Portugali et al., 2012), a fact grasped with pioneering foresight by Jane Jacobs (1961).

The fields of urban studies and land-use control fail to make as thorough and radical consideration of complexity as seems necessary. As Batty and Marshall (2012) note, 'There is still a considerable gap between the sorts of theories and models … that have been developed to enrich our understanding of cities using complexity

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theory and their use in informing planning' (p. 43). See also Wilkinson (2012): 'What is … surprisingly is how little attention has been given to exploring forms of spatial planning and governance that respond to the city as a complex adaptive system' (p. 243). In brief, 'complexity theories were applied to cities only partially' (Portugali, 2012a: 55).

Innes and Booher (2010: 32) also evidence the need for planning to turn to the contemporary paradigm of complexity science. They observe,

> Many of our colleagues, unfamiliar with this rich body of ideas and theory, dismiss it as unnecessary. After all, we already know the world is complex. What else is there to say? Complexity science however is a lens which provides illuminating, even transformative, ways of understanding what is going on in the world. (See also Byrne, 2003)

Taking the marked complexity of the city seriously would entail profound revision of not only the way in which we *interpret* it but also – as I shall try to show – of how we *intervene* in its regulation. Considering cities as complex systems is obviously a matter of perspective – a perspective that for many reasons is not easily or generally accepted. The article will elaborate on the added value of introducing a complexity perspective: on the one hand, in order to discuss how traditional approaches to planning and regulation have shortcomings, and on the other, to show how this could enhance the design of regulatory instruments. First, I shall identify different kinds of explanations and predictions of social phenomena (in the section 'Kinds of explanations and predictions: a Hayekian approach to complexity'); second, I shall draw a distinction between different kinds of regulative instruments – trying to connect them with the kinds of explanations and predictions on which we can actually rely, and identify which of them is best suited to our complex urban realities (in the section 'Kinds of regulatory tools: an indirect approach to socio-spatial ordering'); and third, I shall suggest some conclusions regarding the approach to complexity and self-organisation which I consider the most promising (in the section 'Final remarks: accepting the challenge of complexity and of self-organizing structures').

In some earlier works, I have tried to establish links between the problem of *complexity* and the question of *regulation* (Moroni, 2011b, 2012a), without, however, expanding on the crucial issues of explanation and prediction in the social realm, which are the principal focus of this article. Focusing on the pivotal issues of explanation and prediction also allows me to better illustrate why the answer to the problem of complexity cannot be linked solely to a change in the ways in which we construct the instruments of intervention, or to an increase in their flexibility, but must rather seek a more radical change in the regulatory instruments themselves. Moreover, this is also an opportunity to consider a number of significant criticisms brought against my approach (primarily by Alexander, 2012a, 2012b). And it is also an opportunity to clarify that a complex spontaneous order, a self-organizing order, is not an anarchic one, but instead an order that needs *certain kinds of rules* (diZerega, 2008). There is therefore no paradox between regulating complex systems and welcoming self-organizing forces, nor is there a need for compromise. As we will see, everything depends on *what* rules we introduce (and *why*).

## Kinds of explanations and predictions: a Hayekian approach to complexity

It is customarily believed that the ideas of complexity and of self-organisation were originally introduced by physicists with reference to physical phenomena, and then imported into the social field as well. But the idea of a complex self-organising system was first developed by the 18th-century social philosophers and economists of the Scottish Enlightenment (Smith, 2008). In what follows, I shall consider how this idea of complexity – which started with the Scottish Enlightenment – has been reformulated by Hayek, and the Austrian and neo-Austrian school more in general. My purpose in this article is therefore not to introduce totally new ideas about complexity, but to show the radical consequences that ensue from certain ideas of complexity. The Austrian-Hayekian approach has a great deal in common with other approaches to complexity (Haken, 1988; Holland, 1995; Strogatz, 2003), but it also has a number of distinctive features (Kilpatrick, 2001; Montgomery, 2000).

### *Explanation of the principle and explanation of detail*

According to Hayek (1978), social sciences have to deal with structures of essential complexity. A complex system is one composed of a very large number of components whose interaction is iterative and recursive (i.e. non-linear), with many direct and indirect feedback loops; it presents unintentionally emergent forms of order; it is self-organising; it is markedly dynamic and adaptive. In this case, the whole is not only more than the sum of its parts but also different from it. The fact that a certain structure has intrinsic complexity means that its characteristics do not depend solely on the properties of the individual components of which it is composed – nor on the relative frequency with which these properties appear – but above all on the way in which these discrete elements interrelate with each other, creating emergent patterns (Hayek, 1967). A complex system is a *structure* of phenomena, not a *mass* of phenomena: its very characteristics are those of a 'general order' whose specific elements are perpetually changing. Self-organisation is certainly one of the most characteristic features of a complex system: this kind of system spontaneously seeks out some form of order, with articulated structures being created randomly; no one deliberately imposes order on its numerous components – the system spontaneously exhibits synchrony.

The crucial point is that when we are dealing with structures of essential complexity (such as social phenomena), it is not feasible to provide *explanations of detail*, but only an *explanation of the principle* (Hayek, 1967, 1978). We may talk of explanation of detail when we are able to explain single events and processes. We may talk of explanation of the principle when we are only able to explain typical kinds of events and processes; in this case, we describe types of patterns that arise when certain general conditions are satisfied. By using the term 'explanation of the principle', the intention is thus to emphasise an explanation of the principle *by which* something works, namely an explanation that tells us how or why something works the way it does (Caldwell, 2004: 383). In other words, what may be achieved in this case is an explanation only

of the central factors which give a systemic pattern its characteristic appearance (Wible, 2000).[1]

While the theories that offer an explanation of the principle can provide the general rule by which certain things function, they can never supply specific values to all the variables implicated in any given concrete situation. As Hayek (1967) observes, the crucial point in studying complex phenomena is that the general patterns which they exhibit are all that is characteristic of the persistent wholes at issue.

A clear example of an explanation of the principle in the social sciences is the (Austrian) theory of the market as a spontaneous order unintentionally emerging from the continuous interactions of several (individually ignorant) economic actors, and self-coordinating through the price mechanism, acting not merely as a telecommunication instrument but also as a catalyst for a true process of discovery. This theory is valuable for explaining how the market process works, but it cannot predict specific market outcomes. In the natural sciences, the most familiar example of an explanation of the principle of a complex biological phenomenon is the Darwinian theory of evolution by natural selection. This theory is of great value for explaining how species evolution works, but it cannot be used to predict the specific direction and outcomes of this kind of evolution.

## *Qualitative predictions and specific predictions*

Consequently, while in certain fields we are able to formulate predictions of specific events, in other cases we are only able to provide qualitative predictions (Hayek, 1967, 1978).

By 'prediction' we mean the use of a general law – or of general laws – in order to derive, from certain statements about existing conditions, other statements regarding what will happen in the future. A prediction is therefore a conditional statement, an 'if-then' statement, combined with the recognition that the conditions considered in the antecedent are in place. In this sense, prediction and explanation are two sides of the same coin (Carnap, 1966; Hempel, 1965; Popper, 1934): in the case of prediction, known rules are used to derive from certain known facts what will follow from them, while in the case of explanation, the same rules are used to derive from the known facts what preceded and influenced them.

When the number of significantly interdependent variables is small, the situation is fairly simple. In such cases, we can specify the aspects of the phenomena concerned with the desired degree of precision. If we imagine that a prediction is expressed by a conditional statement of the kind 'if $X$ and $Y$, then $K$', we can say that the description of $K$ will be specified with enough accuracy to suit our purpose – at least within certain margins (Hayek, 1967). The situation changes completely, however, when the number of the significantly interdependent variables is high, and only some of them can be effectively observed individually. In such cases, we are unable to specify the characteristics of $K$ with the desired precision (Hayek, 1967).

We can therefore distinguish between two different types of prediction: *specific prediction* and *qualitative prediction*. A specific prediction is one able to predict certain discrete events with a sufficient degree of precision. As with any form of prediction, a

specific prediction states only some – and never all – of the properties of a particular phenomenon, but it can narrow down (circumscribe) these properties more closely, and can do so in quantitative terms. Conversely, a qualitative prediction does not predict particular events, but only peculiarly wide 'classes of events'. It can only indicate of what 'kind' the expected event will be – and in doing so it uses 'typical' initial conditions (Hayek, 1967). Qualitative predictions are, strictly speaking, non-specific predictions. As Caldwell (2001: 147) observes, when we state that a price ceiling will result – *ceteris paribus* – in quality deterioration, non-price rationing and black markets, we are making a qualitative prediction. At the same time, when we state

> that, *ceteris paribus*, the incidence of taxation depends on the elasticities of demand and supply that a good faces, we are explaining the principle under which a tax burden gets distributed. When we enumerate the conditions under which we would expect third-degree price discrimination to emerge, or for a cartel to persist, we are providing explanations of when to expect certain patterns of economic behaviour, rather than others, to come about.

To summarise, we can predict only certain general features of a situation which may be compatible with numerous particular circumstances. In this sense, Hayek's ideas on prediction are a sort of impossibility theorem: it is impossible to predict more than broad patterns in a complex social system (McCloskey, 1994).

We can reformulate our considerations by observing that social phenomena may be broken down into their *stable* and *typical* aspects, and into their *unstable* and *unique* aspects. Certain typical aspects may be anticipated. But the myriad of unique aspects are undetermined. As Langlois (1986) observes, it might be more useful to speak not of foreseeable and unforeseeable aspects of events, but of their *typicality* and *uniqueness*:

> Typical features are the relatively stable elements of reality, those that we discover to be repeatable in principle. Unique features, by contrast, are the idiosyncratic, nonrepeatable aspects of reality – that are tied to history and to the particular concrete circumstances in which they occur. (p. 182–183)

In other words, we are able to anticipate events as to their typical features, but we cannot fill in the innumerable, specific details beforehand (O'Driscoll and Rizzo, 1985). And in the case of complex social systems, typicality regards only broad patterns.

To conclude, complex social systems 'do not allow precise prediction of specific events or outcomes of interventions' (Innes and Booher, 2010: 31). This does not depend on a temporary incompleteness of our knowledge, but rather on the inherent features of our mind and the world. In other words, complex systems 'are unpredictable, not because of lack of data, but because of their very nature' (Portugali, 2012b: 213). They are in principle unpredictable (Portugali, 2008).

More precisely – using my previous terminology – it is impossible to make 'specific predictions' about the dynamics of complex systems. The only predictions possible in this case are 'qualitative' ones. In short, I am not claiming that prediction is *always* impossible: I argue that specific predictions are possible only for simple systems, while qualitative predictions are all that we can make in the case of complex systems.

## *The question of falsifiability*

Falsifiability – as the criterion distinguishing between scientific and non-scientific statements, in both the natural and social fields – requires that the logical form of a hypothesis must be such that it can be singled out by means of empirical testing (Popper, 1934). According to Hayek (1967, 1978), the prediction that a pattern of a certain kind will appear in specifiable circumstances is a falsifiable statement. Despite this possibility, the margin for falsifying explanations of the principle is narrow, for three main reasons.

First, falsifying an explanation of the principle empirically is no easy matter, for it is difficult to construct an *experimentum crucis* that will enable a definitive choice to be made between two theories providing an explanation of principle for the same set of ordered phenomena. 'The elimination of inferior rival theories will be a slow affair' (Hayek, 1967: 19).

Second, while the explanations of the principle doubtlessly have an empirical content, this is perforce limited. A theory that provides explanations of the principle does not envisage the possibility of replacing the variables considered in a formal model with particular values. Such a theory will be – in Popperian terms – one of small empirical content: 'Because it enables us to predict or explain only certain general features of a situation … the range of phenomena compatible with it will be wide, and the possibility of falsifying it correspondingly small' (Hayek, 1967: 28–29).

Third, the explanations of the principle will not necessarily be 'simple' explanations. As Hayek observes, it is perhaps better, for the reasons given by Popper, to accept that simple statements must be greatly appreciated in all fields in which they are truly significant, but it seems that there will always be fields in which all such simple statements are inappropriate.

To summarise, while it is unquestionably desirable to make our theories as falsifiable as possible, we must also push forward into fields where it is not easy to disprove them. 'This is the price we have to pay for an advance into the field of complex phenomena' (Hayek, 1967: 29).

It is worth noting here that Karl Popper (1972) initially considered Darwin's theory of evolution to be unscientific because it was not strictly falsifiable: indeed, Darwin's theory does not make any specific prediction that can be contradicted. Popper referred to it as a tautological or semi-tautological theory. Hayek (1967) considered Darwin's theory as emblematic of explanation and prediction of the principle, since it is limited to explaining and foreseeing 'kinds of phenomena'; but this, claims Hayek, does not make it unscientific, because it achieves the utmost precision for the type of complex phenomena it deals with. Popper would later modify his position on this point, moving closer to Hayek's. Popper (1978) admitted that he had changed his mind about his earlier assertions on the logical status of Darwin's theory of evolution and its testability: he now accepted Darwin's theory in the realm of scientific hypotheses.

## *The city as a complex system and the meaning of certain recent urban models*

Cities – as relational networks of heterogeneous multiplicities of functions, activities and practices – are clear examples of complex structures. Theories that interpret them as

self-organizing complex systems (Andersson, 2012; Ikeda, 2004; Portugali, 1999; Webster and Lai, 2003) employ typical kinds of explanations of the principle and qualitative predictions. In short, 'Cities are complex, non-linear systems of networks whose future behaviour is essentially unpredictable' (Hillier, 2012: 61). Observe how, while in material systems the parts are simple and obviously non-intentional (atoms, molecules, etc.), in a socio-spatial system like the city the parts are active, purposeful agents (households, developers, etc.) (Portugali, 2012a).

In the field of urban studies, some formal models (which are based on the ideas of cellular automata, neural networks, fractal geometries and so on – and that show greater sophistication than the traditional ones) have recently been advanced to explain how cities function (Batty, 2005; Batty and Longley, 1994; Dendrinos and Sonis, 1990; Wilson and Bennett, 1985).

It is interesting to reflect more in depth on the sense and relevance of these kinds of models.[2] I shall focus in particular on Michael Batty's (2005) *Cities and Complexity*, which is one of the most important works that have recently attempted to construct new models of urban complexity.

The point that I consider crucial is not so much that models 'are not the reality' and that certain models of the city are 'caricatures' (Batty, 2005: 515) – since every theory or model must perforce involve some level of abstraction – as that *different realities* require *different models* which can provide certain answers and not others.

As Batty (2005) notes at the end of his fascinating book, 'Our models have attempted to extract the essence of dynamic processes generating urban development, but invariably this kind of abstraction focuses on generic outcomes rather than specific predictions' (p. 516). And he continues, 'Our models simply provide ways of thinking about cities' (p. 517); 'these kinds of models inform but do not predict' (p. 518). In line with our previous discussion, not only is this not a negative thing, but it is exactly how it should be.

Again Batty (2005) writes,

> Because our models make extensive use of random motion, and we tend not to be interested in specific predictions per se but in typical steady states, we cannot calibrate any of our models in conventional ways. This immediately poses questions about their applicability, implying that their use in practical policymaking is quite limited. This is entirely so. … This approach to urban simulations is not designed to produce predictions that form the basis of policy. It may be that these models generate insights that inform policymaking. (p. 516)

Once again, it could not be otherwise, nor should it be.

It is therefore impossible not to recognise that proper models of urban settlements cannot avoid providing explanations of the principle and qualitative predictions, not because they are 'models', but because they are models of a particular complex reality, in our case, the city. In short, there are circumstances under which it is intrinsically impossible to construct a 'fully articulated model' (Koppl, 1996), a 'completely formalized model' (Polanyi, 1998). But this does not mean that the only alternative is a 'completely unformalized discourse', because we may look for an intermediate type of answer that is 'theoretically formalized', albeit not 'completely formalized' (Polanyi, 1998). In such a case, the logical, mathematical formulation is significant only in theory, not in

practice. The equations of the models are interesting and relevant inasmuch as they exhibit certain logical features of a certain problem, but they cannot be used to solve the problem (Polanyi, 1998).

In other words, while models of social complex phenomena can be expressed in the form of formal equations, these equations – unlike certain laws of physics – remain in 'algebraic form', since the parameters are themselves quickly changing variables. In the case of formalised symbolic models describing complex social phenomena, the values of the variables cannot in fact be ascertained (Hayek, 1967).

It is usually thought that the knowledge generated by our models is useful in guiding our choices and actions directly. Instead, the real usefulness of models of this kind is, in many cases, that they clarify what we *cannot* know or what we *cannot* do. As Hayek (1967) notes on discussing models that provide only explanations of the principle and qualitative predictions: 'Such models are valuable on their own, irrespective of their use for determining particular situations, and even where we know that we shall never have the information which would make this possible' (p. 16).[3]

To conclude, the understanding of the general mechanism which produces patterns of a certain kind is not 'a tool for specific predictions but important in its own right, and … it may provide important guides to action – or sometimes indications of the desirability of no action' (Hayek, 1967: 40).

## Kinds of regulatory tools: an indirect approach to socio-spatial ordering

### *Patterning-instruments and framework-instruments*

To return to the problem of regulating a complex social system, the question is therefore this: how can we regulate a complex system – the city – of which we can have only an explanation of the principle and qualitative predictions? In Portugali's (2012c) words, 'Can there be a planning system that is not dependent on [quantitative] prediction …, in other words, a planning approach that will be tuned with, and reflect, the city as a complex self-organizing system?' (p. 135). See also Marshall (2012): 'The challenge of planning becomes one of how to intervene in or attempt to organise a largely artificial open system where there is not full knowledge of the system' (p. 201). See also Wilkinson (2012): 'Complexity theory informs spatial planning and governance … by challenging modes of governance based on the … assumptions of predictability and controllability, such as … "predict and plan"' (p. 247).

As I will try to show, this is not a problem for regulation *in itself*, but for certain orthodox kinds of regulation which presume that they use regulation in order to achieve specific spatial configurations or arrangements – an idea that entails being able to have explanations of details and specific predictions of the system to be regulated. In order to obtain a desired social–spatial trajectory or end-state, in fact, a 'substantive coordination' of the various urban uses and activities is needed, and this would require detailed knowledge and quantitative predictions of the elements that are to be substantively coordinated.

To explore this problem, I shall recall a distinction between two types of *approaches* to social order: teleocracy and nomocracy (Moroni, 2010, 2012a).

By *teleocracy*, I refer to a form of government – a social ordering system – in which 'patterning-instruments' are the main tools used by the state to regulate (not only its actions but also, and in particular) the actions of private parties. If framework-instruments are employed as well, they have only a secondary, less relevant role.

By *nomocracy*, I mean a form of government in which only 'framework-instruments' are used to regulate private actions; whereas patterning-instruments are introduced solely as means to discipline and guide public actions (e.g. to supply basic public infrastructure on public land with public funds). In the case of nomocracy, the point is not necessarily (as Alexander (2012a: 40) claims) the 'minimisation of collective intervention', but the idea of radically changing the *way* in which we intervene. The crucial issue is not the *volume* or *quantity* of the state's activities, but the *kind* or *nature* of its activities. Alexander (2012a: 73–74) is instead entirely correct when he notes that both teleocracy and nomocracy can be democratic – if by 'democracy' he meant a consensual, deliberative mode of taking public decisions. In this case, my point is not merely that nomocracy is compatible with democracy (indeed, the same is true of teleocracy), but that nomocracy is crucial for a *liberal*-democratic regime: in this perspective, democratic decision procedures can start only after a liberal institutional framework has been established, and only within the limits that it sets in order to prevent public bodies from indiscriminately interfering in individuals' lives (Moroni, 2011b). In short, the public authority must act both *per leges* and *sub lege*. Observe that it is not for democracy, but for *liberal*-democracy, that the rule of law is crucial.

I shall now resume the general discussion and seek to clarify the distinction between the two types of instruments that I have termed *patterning-instruments* and *framework-instruments* and that I have used to define the nomocratic and the teleocratic approaches.

First, we have patterning-instruments. In the case of land use, 'patterning' refers to a particular configuration or arrangement of the urban system. The typical tool is a comprehensive set of prevalently 'map-dependent rules' (Alfasi et al., 2012) – that is, rules which are different for different tracts of land within the same city – which I call 'directional' (Moroni, 2010). Patterning-instruments try to define the role of the diverse parts or components of the urban structure. They look for a form of 'substantive coordination'. They try to generate a social order directly: their aim is to obtain a certain correspondence between the rules introduced and the emerging socio-spatial order. They are 'shaping-devices', and they are 'future-oriented'. An example of patterning-instruments is the traditional land-use plan still widely used. As Andreas Faludi (1986) observes, such plans are collections of 'statements referring to specific situations' (p. 75): site Z can be developed within 2015 by building three-storey residential blocks for Y number of people and so on; site W can be developed by constructing an office building X metres high and so on. Note that patterning-instruments – such as more or less traditional land-use plans – usually rely strongly on forecasts, and on specific predictions in particular, in order to exercise detailed and differentiated control on land-use development; as Kaiser et al. (1995) write, 'Land-use planning requires long-range forecasts' (p. 117). Take for instance the role played by demographic forecasts in land-use planning. In conclusion, orthodox planning involves 'conceptualising the city as it *might* be in the context of normative positions on how it *ought* to be'; in this perspective, planners 'try to forecast what the future city might be, and how its dynamics might be controlled or managed, both then

and between now and then' (Johnson, 2012: 167). Each new plan needs new specific predictions for the territory at issue.

Second, we have framework-instruments. In the case of framework-instruments, the typical tool is a set of prevalently 'non-map-dependent rules' (Alfasi et al., 2012) which I have termed 'relational' (Moroni, 2010). By 'non-map-dependent rules', I mean non-map-dependent within the pertinent territory of the relative public authority; each municipality will therefore have *its* non-map-dependent rules. Framework-instruments do not define the specific role of the various parts and components of the urban structure; rather, they merely *exclude* certain interrelationships among them. They introduce only a form of 'abstract coordination'. They try only to generate a social order indirectly: the rules they introduce and the emerging socio-spatial order do not coincide. Framework-instruments are not future-oriented but 'present-oriented', and they are not shaping-devices, but 'filter devices'. Filter devices imply simply avoiding certain – a few – negative effects, and leaving all the other possible outcomes free. A paradigmatic example of a framework-instrument is an *urban code* (Moroni, 2010, 2011b, 2012a). Framework-instruments do not rely on specific predictions: they are independent from predictions, or they are dependent only on very general *qualitative* ones. Observe, in particular, that framework-instruments do not need fresh predictions – regarding the territory at issue – whenever they are introduced or revised.

## *On the urban code as a paradigmatic example of a framework-instrument*

Urban codes are based on (non-directional, but) relational rules that are few, simple, generic, end-states-independent, long-run oriented and prevalently 'negative'.

That is to say, they are rules that (1) are few in number, (2) are plain and unambiguous in their formulation (i.e. rules that eschew technicality, intricacy and indeterminacy), (3) refer to general types of situations or actions and apply equally to everyone, or at least to extremely broad classes of individuals (they must be applicable to an unknown and indeterminable number of instances and persons), (4) are independent of any specific end-state, (5) must serve in the long run (they must be stable, and adhered to for long periods – clearly, the only rules that can remain stable are those that deal with general aspects of local urban reality and do not claim to control its details) and (6) merely prohibit individuals from interfering with the private domain of other individuals, rather than imposing some active duty or action (they merely serve to prevent certain severe conflicts and predefined tangible and direct harms; their purpose, therefore, is not to prohibit certain activities in particular places of the city, but rather directly to prohibit certain externalities everywhere: in other words, the issue is not use, but the negative *effects* of use).

The relational rules collected in the urban code refer to *typical* situations – ones that are repeatable and time-independent – and they are based on qualitative, not quantitative, knowledge. I refer to rules of the following kind: 'No land transformation and no building development or use may produce externalities of type E, F and D'; 'No building of type H may be constructed within X metres from building of type K'; and so on. These rules define (unacceptable) *relationships* among elements of the urban fabric. Relational

rules of this kind must be introduced, not with any specific spatial configuration or arrangement in mind, but merely to provide the means for fulfilment of the varied and incommensurable separate purposes of the city's many different inhabitants, consumers and developers. The urban code is thus concerned solely with the impersonal and impartial framework of social activities, not with their concrete trajectory. It accommodates the unforeseen, giving ample space to the city's adaptive and self-organizing capacities, to its emerging features and potentialities. Relational rules therefore cannot be designed to produce particular foreseen benefits, but must be considered as multi-purpose devices. Only the reciprocal sphere of the free action of urban actors is specified, and ample scope is provided for the activation of local, dispersed knowledge. Relational rules embrace and encourage variety and diversity of structures, spatial functions and activities, increasing the possibility to tackle uncertainties. The point is not to design the future, but to permit the emergence and development of the 'urban'.

The relational rules of an urban code reduce uncertainty but do not eliminate it. For instance, I cannot know in advance precisely what will happen to Lot B that lies alongside my own land (what type of land use will take place, what activities, how many inhabitants or employees will come, etc.). I can only know that on Lot B (as on other plots of land in the city), regardless of the type of buildings that will be constructed there, certain negative externalities are to be excluded (such as certain noise levels, specific kinds of pollution, etc.).

Relational rules can be applied in a quasi-automatic fashion, without any marked discretionality. Current lengthy and uncertain permit processes can in this case be replaced with more 'automatic' and faster ones. The rules of the urban code cannot be introduced or changed through simple majorities, but only through some kind of supermajority. No kind of negotiation between the public actor and private actors is possible with regard to these rules.

When I speak of relational rules, I refer not so much to *procedural rules* (i.e. rules for the production of rules or for the activation of processes) as to *rules of conduct* (i.e. behavioural rules directly and uniformly controlling the ways in which private citizens may or may not use or modify land and buildings). The issue is not so much 'processes' versus 'outcomes' (Alexander, 2012a: 40) as 'relational rules' versus 'directional rules'.

As correctly observed by Alexander (2012a: 45), the nomocratic idea of an urban code that I suggest has some similarities with so-called performance-zoning. Although this is an interesting option (Acker, 1991; Baker et al., 2006; Marwedel, 1998; Ottensmann, 2005), it is rarely taken. Among the few examples, I cite the following: Gay Head, Massachusetts, 1972; Buckingham Township, Pennsylvania, 1974; Bay City, Oregon, 1978; Fort Collins, Colorado, 1981. It might be said that the urban code envisaged by my proposal is a sort of performance-zoning but (1) without zoning, (2) extremely simple and devoid of discretionality, (3) largely centred on general prohibitions concerning what must not be done and (4) conceived from a strictly nomocratic standpoint. (By contrast, many of the jurisdictions where performance methods survived hybridised them with traditional zoning: Baker et al. (2006).) Alexander (2012a: 45) suggests that some similarities can also be found with some form-based codes which the New Urbanists introduced to revolutionise traditional zoning (for an overview, see Talen, 2012: 175–200): this is true only as regards certain specific experiments, and not as regards the

whole movement – that comprises very different regulative (and sometimes excessively design-based) approaches. The similarities are much greater (Alexander (2012a: 44) is entirely right in this regard) with a recent proposal to restructure the Israeli planning system and convert it into a system based on general laws (Alfasi and Portugali, 2007).[4]

## *The rationale for preferring framework-instruments to patterning-instruments for socio-spatial ordering*

In cases where our theories and models are able to provide only explanations of the principle and qualitative predictions, it is impossible to monitor and control in detail the way in which the systems function. Where our predictions are limited to some very general and, in many cases, only negative attributes of what is likely to happen, we clearly also have little power to control the trajectory of developments deliberately. As a consequence, it is impossible to use patterning-instruments like land-use plans to control and guide the development of a city. As evidenced, patterning-instruments strongly rely on the possibility to explain in detail and make specific predictions; but these goals are unattainable for evolving phenomena like cities. Observe that in the case of complex systems, it is impossible not simply to know the future, but also to imagine an optimal future state.

> With a designed artefact such as a machine or building, the optimal future state may be equated with the finished product in operation. This optimal state is usually foreseen, as it relates to the intention of the creation of the artefact … With an ecosystem, by contrast, there is no knowable optimal future state. There is no 'mature form' as such … With a city, similarly, there is no knowable optimum form. (Marshall, 2012: 200)

The recognition of complexity in a radical way therefore seems to suggest a shift from patterning-instruments used as whole-coordinating devices – such as 'urban plans' centred on some form of zoning and differentiated land-use regulations – to framework-instruments used as filter devices – and, in particular, to what I call 'urban codes' based on uniform and impartial rules of conduct. (I think the need for this shift is *also* supported by ethical reasons, such as respect for the rule of law, but I shall not directly consider this question here: see Moroni (2007).)

## *The need to change the regulatory instruments in themselves, and not merely modify how they are revised and how they are constructed*

In the case of the city, I do not think that we can avoid the difficulties of making explanations of detail and specific predictions by modifying *the way in which patterning-instruments can be revised and adjusted in the ongoing planning process*: for example, by making land-use plans more flexible and adopting a form of continuous planning in order to create ongoing feedback between a review of predictions and corrections of plans (as many planning theorists propose, for instance: Branch, 1981; Jessop, 1973; Kaiser et al., 1995; McLoughlin, 1969; Regulski, 1981; Webber, 1974). In Webber's (1974) words, a necessary condition of the planning method is 'the continuous monitoring of the systems being planned. A constant flow of information on actual outcomes is

fed back into the planning system to signal forecasting errors and to actuate corrective steps' (p. 216). As I said, I do not think that this can be the solution because it would require running after something that cannot be caught. Moreover, it is difficult to know, abide by and respect rules that constantly change; if legal rules are continually subject to change, the information that they provide becomes negligible and useless. Nor do I think that we can avoid the problem by merely changing *the way in which patterning-instruments are constructed*: for instance, by raising, in this case too, the issue of 'participation' (as many planning theorists do, for instance: Cuhls, 2003; Gál and Fric, 1987; Perloff, 1980) or, more in general, of collaborative–communicative interaction. Perloff (1980) writes, 'Planning must seek to make the forecasting effort a usefully integral element of the political process of decision-making, including participatory approaches to population and other kind of forecasting' (p. 286). However, if explanations of detail and specific predictions are intrinsically impossible in the case of a complex system like a city, any participative, communicative, collaborative process – no matter how extensive, transparent and shared it may be – cannot solve the root problem.

In conclusion, I think we must on the contrary make a more radical change *as regards regulatory instruments in themselves*. As I said, the recognition that it is impossible to explain in detail and to make specific predictions suggests a shift from a teleocratic approach (seeking to generate an order of urban activities directly) to a nomocratic approach (generating order only indirectly). Moreover, in this way, we can take full advantage of the self-organising potential of complex systems such as cities (Gordon, 2012; Holcombe, 2013; Ikeda, 2004; Moroni, 2012b), and of their beneficial effects.

The issue is therefore not to construct a flexible, adaptive system of land-use planning so that it is possible constantly to monitor (and adapt to) the ongoing social dynamic, but rather to have a stable and simple set of abstract and general relational rules that enable society itself to be highly flexible. In other words, the point is not to keep options open for the local government – preparing 'incomplete plans' so as to be able to respond to unforeseen events – but to leave options open for society. It is not the plan that has to follow a continuous trial-and-error process, but society itself. In other words, the point is not 'to work with the flow', 'to interact with the flow', but 'to permit the flow'. Nor is the issue a simple matter of having more participation – dialogue, communicative interaction and so on – in constructing more or less traditional patterning-instruments.

This does not mean that patterning-instruments (such as land-use plans) should be discarded in their entirety, rather, that they should only be used to control circumscribed public sector activity, and not the general working of the city and the activities of the private urban actors (Moroni, 2007, 2010). Land-use plans may be used only to constrain the public parties to creating infrastructure (e.g. roads) and services (e.g. school buildings) on public soil with public resources.

In short, I think that local governments must *regulate* the actions of the private actors (allowing landowners, developers and so on to make free use of their lands and buildings within a framework of relational rules that apply equally to everyone, and as long as such use does not create negative externalities), and *plan* their own actions (trying to coordinate the use of public resources at their disposal in a responsible and efficient manner, to guarantee infrastructures and services). (Compare with Holcombe, 2013.)[5]

The crucial difference between the first case – 'regulating others' – and the second case – 'planning for itself' – is that in the latter the local government is involved in a simpler enterprise because it is not trying to plan the entire set of *private* activities in the city (conducted on private land, with private resources and in light of the various, totally different and irreducible aims of many individuals), but a very specific kind of its *public* activities (i.e. 'things' built on public land and with public funds, and in light of a unified public aim). Observe also the difference between introducing *rules* of private conduct as regards land and building use and directly planning and building *something*.

Portugali (2012c) also notes that for some simple objects, like a bridge, we can 'close the system' (p. 130) and have full or almost full control over them – something that is impossible for a complex social self-organizing structure like the city as a whole.

This is not to forget or to disavow the central argument of this article. Rather, it is to reinforce that argument. In fact, it once again evidences the crucial difference between seeking to direct the activities of others as separate and independent members of a complex system, and seeking to organise our own delimited and circumscribed activities.

## *Three important criticisms*

A first criticism of my approach is that the distinction between patterning-instruments and framework-instruments is an over-simplification with respect to what happens in reality (Alexander, 2012a, 2012b). I admit my distinction is a form of simplification (as is every attempt to introduce theoretical categories), but not necessarily of over-simplification. I think the distinction at stake can have some importance for – and shed some light on – everyday regulatory practices. Let us consider an example: transferable development rights (TDRs). We can distinguish between *zoning-integrative* and *zoning-alternative* TDR programmes.

Almost all TDR programmes implemented at present belong to the zoning-integrative TDR family. ('TDR can help make zoning more effective, and strong zoning is essential for a successful TDR program': Nelson et al., 2012: xxiii.) Typically, a zoning-integrative TDR programme functions as follows. Through a zoning plan, the public authority defines in detail the land-use configuration that it aims to achieve. The zoning plan identifies areas to preserve – 'sending areas' – and areas to develop – 'receiving areas'. Sending and receiving areas are then differentiated into a number of sub-categories, according to the planned uses, characteristics and densities of the plots. A specific development ratio is assigned to each class. The criterion used to differentiate among areas is prevalently geographical (map-dependent): because the aim is to achieve a specific land-use configuration, it is necessary to treat different areas differently. In this case, the aim of the public authorities is to achieve a desired overall state of affairs through deliberate coordination of the private independent urban activities.

In the case of zoning-alternative TDRs, the transfer of development rights is independent from any zoning plan (among the few proposals in this regard, see Moore (1975), Thorsnes and Simons (1999) and Moroni (2013)). In this case, there is no zoning plan defining the overall land-use configuration that has to be implemented. The local government's role is restricted to determining the total development quantity to be permitted, through the decision on how many TDRs to allocate. Once this overall quantity has been

decided, TDRs are distributed with an identical ratio (e.g. X cubic metres per each square metre, Y development units per acre, etc.), and the market is free to re-allocate those rights among landowners. No overall distinction between sending and receiving areas will be envisaged. A zoning-alternative TDR programme might, in certain cases, designate some sending areas to be preserved – without using geographical criteria but instead, for instance, categorical ones[6] – but no specific receiving areas. This system is similar to the cap-and-trade environmental policy approach to reducing pollution. Public authorities maintain many of the traditional command and control prerogatives, but they do not define the desired final state of affairs.

To resume our more general discussion, zoning-integrative TDR programmes are a clear case of *patterning-instruments*, while zoning-alternative TDR programmes are a case of *framework-instruments*. This shows that the proposed distinction can be helpful in critically reconsidering practices, and advancing new perspectives. To conclude, Alexander (2012b) is right to suggest that we have always to consider the 'messy face of reality' (p. 73); but this does not per se demand 'a retreat from categorical generalizations' (p. 72), it simply demands the introduction of useful categories.

A second criticism points out that much practice seems to consist of various mixtures of my categories (Alexander, 2012a, 2012b). In this regard, it is important to differentiate sharply between the 'nomocracy vs teleocracy distinction' and the 'framework- vs patterning-instruments distinction'. The former is a distinction between *approaches*, while the latter is a distinction between *instruments*. My perspective recognises that both nomocracy and teleocracy are particular mixtures of both framework-instruments and patterning-instruments. What is peculiar to nomocracy (as a normative approach) is that it recommends a *particular mixture*: framework-instruments must be used to regulate private activities, patterning-instruments to guide public actions. Hence, I agree with Alexander when he claims, referring to my binary categories, that the real world demands both; but, in my opinion, this is true not of approaches (nomocracy and teleocracy, which are, by definition, alternatives to each other), but of instruments (framework-instruments and patterning-instruments – that teleocracy and nomocracy suggest mixing in different ways).

A third criticism observes that certain old forms of urban regulation were framework-instruments focused on relational rules (Alexander, 2012b). This is clearly right. Alexander (2012b: 74) correctly recalls, for instance, regulations and codes that controlled development and construction in mediaeval European cities; and, particularly, the well-known experience of the so-called Assize of Nuisance that in London, after 1300, codified building rules in order to respect neighbours' rights ('This was planning without plans, for the primary purposes of preventing nuisances and defending property rights' (p. 74)). Accepting this totally correct view, nomocracy can be considered as a perspective asserting that the error of a broad quota of 20th-century theory and practice of land-use regulation consisted in undervaluing the importance of these already experimented forms of relational rules, while trying to give a primary role to totally different kinds of directional rules. Instead of developing, improving and extending certain old forms of relational land-use rules, the 20th-century approach to land-use issues thought it was necessary to *substitute* a broad quota of them with directional rules. Contrary to the traditional narrative, we may say that zoning was not

introduced in the 20th century to deal with externalities, but to go beyond traditional nomocratic systems in order to pursue a teleocratic approach (Clayes, 2004). See the very interesting case of New Haven studied by Cappel (2002). In brief, I am not asserting that framework-instruments are something totally new. I clearly recognise that we have already employed them in the history of cities. But in the 20th century, we have forgotten their importance. I am obviously not recommending a return to the past; rather, I am simply advocating that we should press ahead with constructing a regulatory system suited to contemporary reality while also capitalising on past experiences.

## Final remarks: accepting the challenge of complexity and of self-organizing structures

In face of the complexity of social systems such as cities, two main approaches are possible.

A first approach – the one more widely adopted in planning theory – still centres on the idea that patterning-instruments, either orthodox or more sophisticated, are those best suited to tackling *crucial* urban problems and land-use issues. On this view, and in order to address the problem of the complexity and unpredictability of complex systems, it is suggested that we make our patterning-instruments more adaptable and flexible, and/or increase participation and dialogue in their development (it is interesting to quote Alexander (2012a) here: 'Communicative practice … or collaborative planning are essentially teleocratic' (p. 40)).

A second approach foreseen in Moroni (2007) is the one investigated further in this article. It instead proposes that the problem of complexity and intrinsic unpredictability requires a radical overhaul of the tools used to regulate land use – especially by exploring the idea of shifting the emphasis to framework-instruments (such as urban codes; see also Alfasi and Portugali (2007), Portugali (2012b), Webster and Lai (2003)). To avoid misunderstandings: neither generic deregulation nor laissez-faire 'liberalism' is suggested in this case; simply, a different way to take seriously the need for regulation (Moroni, 2012a). Indeed, I believe that *law* must once again assume the central role that it has regrettably lost over time (Moroni, 2007).

As I emphasised above, one gains the impression that the former approach is in some respects (flexibility/adaptation) incorrect and in others (participation/dialogue) incomplete or partial,[7] while it could be interesting to extend the debate to include also the latter approach.

Whatever the case may be, for the discussion to continue fruitfully, I agree with Alexander (2012b) when he writes, 'Better informed future discussions may be less about … meta-theories of planning, and more about exploring their implications at the micro-level of applied planning practices' (p. 44).

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## Notes

1. Compare with Lawson's (1997) concept of *demi-regularities* as the only kind of laws identifiable in complex social phenomena.
2. I have made a first attempt in this direction in Moroni (2009, 2012c).
3. See also the distinction between *modelling for understanding* and *modelling for forecasting* in Hanson (1986). As Hanson observes, referring to the traditional use of models: 'Much of the modeling conducted in planning has been for the purpose of forecasting the future' (p. 50). Some contemporary scholars are also inclined to use more recent models (which claim to take complexity seriously) as sophisticated predicting devices: 'By so doing, these practitioners of complexity theory run into a paradox: they claim that cities are complex systems but treat them as if they were simple systems' (Portugali, 2012a: 53).
4. Conversely, there are few similarities with another example cited by Alexander (2012a: 45), namely, Milan's 'Framework Document' (2001). This document proposes an interesting approach, but one quite different from my own.
5. This seems to me not particularly different from an interesting suggestion made by Alexander (2012a):

   > A planning subject should act like an institution in situations of high complexity and low interdependence (when 'planning for others'), using nomocratic tools to promote common values; when 'planning for itself' it should use teleocratic tools acting as an organisation to realise its goals. (p. 44)

   Alexander (2012b: 77–78) maintains that this approach is different from mine, but I see more similarities than differences: on this, see Moroni (2011a).

6. *Geographical* criteria distinguish areas according to their specific location; the criterion is map-dependent in that the distinction rests on non-general and non-abstract rules. *Categorical* criteria distinguish areas according to substantive characters (e.g. hydrogeological characteristics). The geographical criterion – the most widely used – is typical of patterning-instruments; categorical criterion *can* be compatible with framework-instruments.
7. Observe that whereas the idea of having flexible/adaptive rules is incompatible with the (nomocratic) position proposed in this article, the idea of increasing communicative participation and dialogue can be compatible with it, provided that the focus shifts from patterning-instruments to framework-instruments, and as long as it is not considered a panacea but merely one 'ingredient' of a more widely revised approach.

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