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Complexity and the Cathedral: Making Law and Economics More Calabresian

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Abstract: This article argues that the Calabresi and Melamed's "Cathedral" framework of property rules, liability rules, and inalienability rules needs to be extended using the tools of complex systems theory in order to capture important institutional features of the law. As an applied field, law and economics looks to law in choosing the appropriate analytical tools from economics – something that Calabresi has identified (in strong form) as law and economics as opposed to economic analysis of law. Recognizing law as a complex system requires a rethinking of some Realist-inspired assumptions that underpin economically inspired analysis of law. These assumptions include a preference for narrow, concrete concepts and a skepticism about traditional doctrines and baselines – and ultimately Legal Realism's extreme nominalism and the strong bundle of rights picture of property. The article shows how the Calabresi & Melamed (C&M) exhibits gaps that can be addressed by systems theory; these include narrow entitlements to engage in specific activities, liability rules that allow an affected party to buy out an activity (Rule 4), opportunistic behavior by parties that destabilizes liability rules, and the role of equity as an institutional response. Extending the C&M framework to treat it as a system helps prevent the C&M framework from flattening the law out. If we supplement the C&M framework to take account of law as a system, we can bring it closer to Calabresian law and economics.

Keywords: Property Rules, Liability Rules, Economic Analysis of Law, Law and Economics, Property, Complex Systems, Equity

JEL codes: A12, K11, K13

Introduction

This article revisits the Calabresi and Melamed (C&M) framework of property rules, liability rules, and inalienability rules – the landmark "Cathedral" article (1972) and its vast progeny – and argues that the framework needs to be extended in order to take the law seriously

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as a system. Treating law *as a complex system* allows us to capture the institutions of the law and their dynamic quality. The tools of complex systems theory, only just beginning to be employed in economics, can supply what is needed in order to take the law seriously on its own terms and not in a procrustean fashion.

In the C&M framework, an entitlement is a right to engage in some kind of activity. It can be protected against nonconsensual transfer, with the aim of forcing would be takers to obtain the holder's consent: this is a property rule. Entitlements can also be protected by forcing takers to pay officially determined damages; in liability rules an entitlement can be taken at the official (non-market) "price." Alienability rules prohibit the transfer of an entitlement under some or all circumstances. Despite the use of the term "property," the structure of entitlements here bears little resemblance to the familiar legal notion of property as (rough) the right to a thing protected by norms of exclusion and rules governing use. As we will see, the C&M framework assumes a strong version of the bundle of rights picture of property, which is often contrasted with traditional thing-based approaches to property in the law.

Specifically, we need to get beyond some of these post-Realist assumptions on which the entire enterprise of economically inflected legal analysis rests. Thus, aspects of property law that appear irrelevant or distracting on the C&M framework, such as property as a right to a thing, directional causation, and robust rights and duties are all more easily understood where the entitlements to individual activities (to pollute or not to pollute, to build or not to build, to farm or not to farm, to ranch or not to ranch) are not separately delineated but part of an interacting cluster that evolves in some directions more easily than in others. Some entitlements – the right to grow plants and the right to draw water – interact intensively, whereas others – the right to occupy the surface and the right to determine whether airplane fly ay cruising altitudes over the surface – do not. Unlike in a hypothetical world of zero transaction costs, the complex nature of the system of interactions forms part of the backdrop of transaction costs that are part of the real world. So getting beyond Legal Realism and towards a more real realism requires us to put system effects back into the picture. It turns out that some traditional aspects of the law, from property as a law of things to the role of equity in remedies, receive an explanation and partial justification in light of system effects.

Extending the C&M framework in this way points to its larger significance. Calabresi (2016) presents the C&M article as a paradigm example of law and economics, which he distinguishes from the economic analysis of law. The economic analysis of law employs economics as an "Archimedean point" for analyzing law, and the methodological traffic is all one way – from economics to law. This is as true of first generation economic analysis of law applying standard microeconomics, as pioneered by Richard Posner (2014 [1972]), as it is of more recent behavioral, experimental, and empirical versions of law and economics. Calabresi (2016) reserves the designation "law and economics" for a different perspective on the subject, one which allows law and economics to inform and critique each other. Thus, not only can one explain and evaluate the law in economic terms, it is also possible and sometimes highly desirable to question and enrich the methodology of economics when some real world legal phenomenon is not well-captured by conventional tools of economics, whether mainstream neoclassical economics or some other more heterodox approach. It is this latter style of two-way traffic between economics and law that Calabresi sees as characteristic of his own work,

especially that involving the extent and shaping of preferences (e.g., Calabresi & Bobbitt 1978). He now sets the C&M framework in a larger context of different types of societies – collective, libertarian, and social democratic – and identifies the liability rule as a distinctly social democratic device, not just in its results but in its very nature.

A more modest version of the distinction between law and economics and economic analysis of law would take seriously the nature of law and economics as applied field: the law, including its doctrines and structures, are potential objects of economic analysis and can sometimes suggest the appropriate tools for analyzing them. Among these tools is complex systems theory, which will, I argue, hold promise for capturing aspects of property law that are elided in the C&M framework and its progeny. The entire framework of property rules and liability rules needs a further push along the road from economic analysis of law to law and economics, i.e. to make the application to law matter to the choice of tools from economics. This article – to adapt a phrase – carries Calabresi further (cf. Calabresi 1991).

A word of caution is necessary at the outset. Like Coase and Hohfeld, Calabresi and Melamed have been so generative of a vast and variegated literature, that it is sometimes hard not to read into the article positions taken by later writers. Some of these later scholars have explicitly parted from C&M in various respects, and sometimes they have used the C&M framework in an "economic analysis of law" fashion, not quite in the spirit of the 1972 article itself. Nonetheless, I would like to focus on aspects of the C&M article and the entire liability rule research program that would benefit from complex systems theory.

This article will first set out in Part I how both the economic analysis of law and what Calabresi calls law and economics are both heirs to the Legal Realist stream of thought. For reasons of tractability and immediacy of policy relevance, economic analysis of law and law and economics take on board assumptions about the desirability of narrow, concrete concepts and skepticism about traditional doctrines and baselines. In property, the nominalism of realism leads to the bundle of rights picture of property. The bundle picture and Coase's skepticism about the directionality of causation form important predicates for the C&M framework. Part II will sketch how complex systems theory and a greater role of information costs can usefully supplement conventional models in law and economics. Part III shows how certain features of the C&M framework obscure the complex system involved in the institutions of property and liability, thereby playing down the law in law and economics. I will focus on how narrow entitlements, liability rules that allow an affected party to buy out an activity (Rule 4), opportunistic behavior by parties as feedback into the system, and the role of equity could all benefit from systems theory. If we supplement this picture to take account of law as a system, we can bring it closer to Calabresian law and economics.

I. Law and Economics as Post-Realism

Most forms of law and economics grow out of the Legal Realism of the 1920s and 30s, and it is the legacy of that movement that is, I argue, what prevents us from making the disciplinary enrichment a two-way one. Later I will show that the C&M framework bears the traces of Legal Realism in key respects and that it is this residual Realism that pushes the C&M

framework away from taking seriously the law in law and economics. So we first must ask what makes law and economics, including Calabresi's version, Realist.

First of all, Realism is associated with evaluating law from a policy point of view. To do so, Realists apply perspectives from other disciplines, typically the social sciences. The Realists believed that this was the rational and pragmatic way to proceed, and anyone who resisted this kind of progress was a mindless formalist. Or worse. The Realists and even more so their successors attributed a kind of bad faith to their opponents, accusing them of trying to smuggle political values, especially classical liberal values, into the law by way of invoking traditional legal concepts and treating law as in any way autonomous. To the Realist, law is in an important sense politics, or, in Calabresi's terms, about preferences, individual and collective.

Now it is sometimes thought that law and economics is a conservative movement. Not in the sense I am offering, though. Calabresi (2016) rightly identifies Posnerian law and economics with Benthamism. And despite Bentham's enthusiasm for property, the major theme for Benthamites is not only reform but deep skepticism about or outright rejection of the received wisdom furnished by the law.

Realism and its offshoots exhibit a hyper-Benthamite skepticism about traditional legal concepts and baselines. In its more extreme forms, Realism disdained legal concepts as transcendental nonsense designed to obfuscate in favor of a liberal status quo underserving of such respect (e.g. Cohen 1935). In its more moderate forms, Realism and its tamer offshoots exhibit a preference for concepts that are shallow and close to the facts on the ground (e.g., Llewellyn 1931). There is much to admire in this latter approach, and the systems perspective I will offer can be regarded as a friendly amendment. There is nothing wrong with asking concepts to serve functions and not to be needlessly far from the particulars they organize. Nonetheless, I will suggest later that the challenges of managing complexity often call for concepts that may seem more "metaphysical" than the Realists and their successors would countenance.

A testing ground for the Realist and the complexity-inspired views of legal concepts is the law of property. Among the most successful of the Realists' innovations was the bundle-of-rights picture of property. Now is not the time to reenter that debate, except to note that it forms an important set of assumptions for the economic analysis of law and for most law and economics going back to Coase and beyond. As Tom Merrill and I have shown, Coase was a hyperrealist in his assumptions about property (Merrill and Smith 2001, 2011). Even when it came to his applied work on the radio spectrum, he assumed that "property rights" meant a list of uses (in this case of transmitting equipment in certain locations at certain frequencies at certain times) and that traditional notions of property were odd and unjustified artifacts (Coase 1959).

Nowhere does this disembodied kind of Realist-inspired analysis come to the fore in higher relief than in Coase's agnosticism about causation (Coase 1960). For Coase the presence of each of the parties is a but for cause of any conflict, which leads him to the idea that it is a matter of policy where to assign liability. In the rancher-farmer example, the animals and the plants are equally causes, just as in a nuisance dispute the polluter and the recipient are both causes of the resource conflict. Coase showed that in a positive transaction cost world liability

matters because it might not be reassigned by contract, and thus he argued the law should aim to assign property rights in a way that will maximize production even if there is no transaction. If ranching and candymaking are more valuable, the entitlement to engage in those activities should be with those engaging in them, and conversely for graingrowing and doctoring.

C&M give this Coasean causal agnosticism a new twist. In their scheme the four-by-four matrix of rule choices arises from two decisions: who gets the entitlement and how is it protected? In the first question, of who "gets the entitlement," the symmetry of the potential answers – Marshall or Taney, polluter or resident, etc. – reflects a Coasean symmetric view of causation. If each party contributes to the resource (or other) conflict, we can imagine placing the entitlement in either party. Now Calabresi recognizes in his other work a range of reasons for deciding this question other than who values the entitlement most. One could place liability on the cheapest-cost avoider, one of the most important concepts in all of law and economics, thanks to Calabresi (Calabresi 1970). Or one could invoke moral reasons for placing the entitlement in someone to not have one's nose punched rather than in the nose-puncher. Indeed, Calabresi is more open to moral factors coming into the analysis at some point than almost any other practitioner of law and economics.

And yet, the C&M framework itself leans towards flattening concepts and smoothing out baselines. As we will see, the narrowness of the "entitlements" in the C&M framework facilitates a Coasean symmetric view of the conflicts: who gets to do a particular activity is a narrow entitlement. Asking the question this way is fine as far as it goes, but we must recognize actual property is not delineated as a long laundry list of narrow use rights, which would be the extreme bundle-of-rights view assumed by Coase for his very different purposes.[1]

The real legal landscape is far from a uniform set of thin, potentially reversible entitlements. We don't regard resource conflicts as up for grabs, and the structure of rights breaks the symmetry. If someone has a right not to be punched, the puncher causes the injury. These rights often pertain to lumpy groups of use rights. These lumpy rights are even often delineated in terms of things, in a way the Realists found naïve and hard to understand (e.g. Cohen 1935, 809, 815). Property prototypically reflects as a starting point what I call an "exclusionary" strategy: delineate a thing and set up rights that define violations in an on/off manner (boundary crossings, touchings) (Smith 2002). It is true that narrow entitlements can be found – think easements, covenants, rights of lateral support, and various contract rights. These devices reflect what I call a "governance strategy" and are reserved for more detachable and high-stakes interactions that are not well-captured by the cruder exclusion strategy. What the C&M framework can be taken to imply – and what successors have taken it to stand for – is that property is actually or potentially all governance all the time (Merrill & Smith 2011, S93-95; Smith 2012,1704). This is a theoretical possibility but would be an actual nightmare.

To make Realism and post-Realism more realistic we need something more, and that something is an appreciation of complexity, to which I now turn.

[1] Coase was trying, as Calabresi notes, to change economics in light of the law, and he was not that interested in explaining the law itself.

II. Adding Complexity (Theory)

The C&M framework has been highly fruitful, and yet it has promoted a thin view of the law. Like the Legal Realism out of which it grows, the C&M framework assumes that law is a set of results or very thin detachable concepts. The richness of the structure comes from outside the law, e.g. from economics. This makes it an example – a sterling example – of what Calabresi (2016) terms economic analysis of law.

I will argue that we need the theory of complex systems and information to transform the C&M framework from an example of the economic analysis of law to being more attuned to the law – more like Calabresian law and economics. A complex system is one in which many parts interact strongly such that it is difficult to infer the properties of the whole from the properties of the parts (effects are nonlinear) (Mitchell 2011; Simon 1981 [1969]). Brains, social networks, and ecosystems are all familiar examples of complex systems, as are markets and economies (see, e.g. Arthur 2015, Miller & Page 2007).

In response to complexity, systems are often organized in a modular fashion: not every node can interact freely with any other. Instead, clusters of nodes interact intensely within the group (module) and more sparsely between groups. This allows a range of activities to take place without destabilizing and hard-to-understand ripple effects (see, e.g., Baldwin and Clark 2000: 58-59, 236-37, 257). Thus, computer hardware and software are organized into modules. Everyday objects like cars are organized into components: brake systems and windshield wipers are semi-separate units, with intense internal interactions and sparser – but important – external interactions. Modularization also allows feedback to be managed more effectively rather than getting out of control.

Modular structures are prevalent and much misunderstood in private law. In property, a major theme for the Realists was debunking the notion that property is a right to a thing. Relying on Hohfeld (1913, 1917), the Realists pointed out that rights avail between people; the duty corresponding to a right applies to persons not to the things themselves. In its more extreme forms, this disaggregation extends to the notion of an in rem (etymologically "in a thing") rights. On the disaggregated approach, in rem rights are simply an aggregate of rights that avail between individuals like owners and corresponding duty bearers.

A further tacit assumption of the bundle-of-rights picture, as reflected in the metaphor of the bundle of sticks, is that the bundle is maximally protean and easily reformable. Ownership might be made of the right to exclude, the right to use, the right to transfer, and so on. The bundle as conventionally conceived is totally nominalist, the idea being that we can figure out on policy grounds which sticks should be in the bundle and which not and then slap the meaningless label of "property" on the bundle if we so choose (e.g. Grey 1980, 69).

By contrast, traditionally and in other legal systems property is styled a law of things. The legal thing serves as a module (Smith 2012). Individual legal relations like the right to build, the right to farm, the power to create an easement, etc., are gathered together, and the group of relations interacts much more heavily with each other than with outside actors and resources and the relations that they are involved in. (Nuisance, servitudes, regulation and the

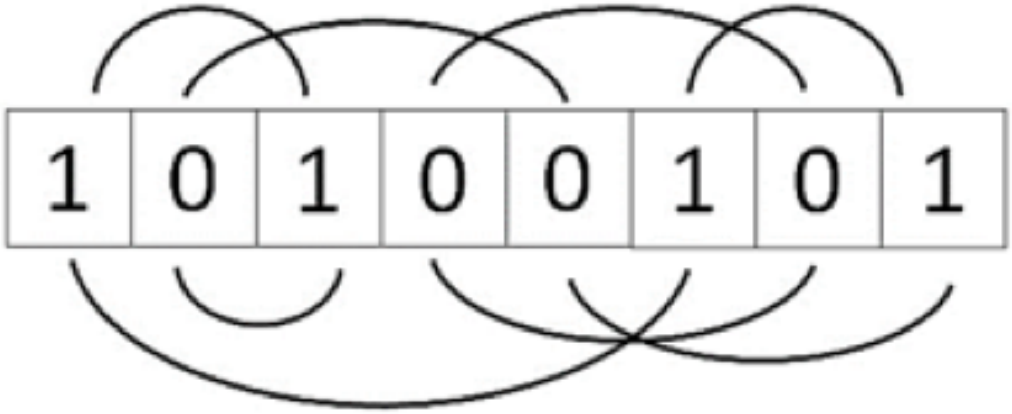
like form the interface with neighboring legal things.) Moreover, these individual relations often need not be separately delineated: the liberty-right to farm is implicitly protected by the right to exclude form a parcel. Again, Legal Realism explicitly denied the importance of things and tacitly suppressed the differential intensity of interactions with the "bundle" versus those outside of it.

To take a concrete example, consider the right to roam. This right is customary in many northern European countries. Recently England and Scotland passed legislation formalizing and expanding the right to roam. In the property literature this was regarded as an unmitigated good: the right-to-roam-stick was given (the extra scope was given) to hikers. The assumption is that this stick is fully separable. When Jonathan Klick and Gideon Parchomovsky (2017) sought to test empirically whether the English legislation had an effect on land values, the only literature they could find entertaining the possibility that the legislation could lower land values was in Smith (2011b, 286; see also Smith (2012, 1717-18), which noted that the interactivity of the right to roam with other activities and entitlements of the owner might have a negative effect on price.[2] Using the passage of the legislation as a natural experiment, Klick and Parchomovsky did find a statistically significant and substantively important negative effect on property prices (with average loss across regions of England of 6% of appreciation, with greater effects in less urban areas, and similarly for Wales). Whether this effect will hold up under further inquiry is worth pursuing. The point here is that the bundle picture with its assumption of detachability and its concomitant suppression of complexity led to a glaring omission in the discussion of the right to roam. None of this is to say that the right to roam especially in its customary form is bad idea or even that the legislation was not worthwhile. It is to say that the bundle picture can be quite distorting.

To be more precise, consider the standard picture of property in the light of an analogy to biological evolution. Many models in property have proclaimed themselves "evolutionary" (e.g., Demsetz 1967; see Krier 2009), but Alston and Mueller (2014) show how different takes on the bundle picture have very different implications for the evolution of property rights. Evolution in biology rests on genetics, and classically genes were assumed not to interact directly. More recent genetics allows for interaction – epistasis and epigenetics. For example, one gene might suppress another or lead to change in another gene. The big question is whether sticks in the property bundle – various rights that make up property – might interact in a similar "epi" fashion. The possibility is depicted in Figure 1 as ones and zeros for the various N number of rights, which might be the right to farm, the right to draw water, the right to park a car, and so on. The presence or absence of some of these rights alters the effects of the presence or absence of others (denoted by links of number K), and sometimes there is no interaction (i.e. there may be no epistatic couplings, denoted by the absence of links) (Alston & Mueller 2014, 2263, Fig. 1).

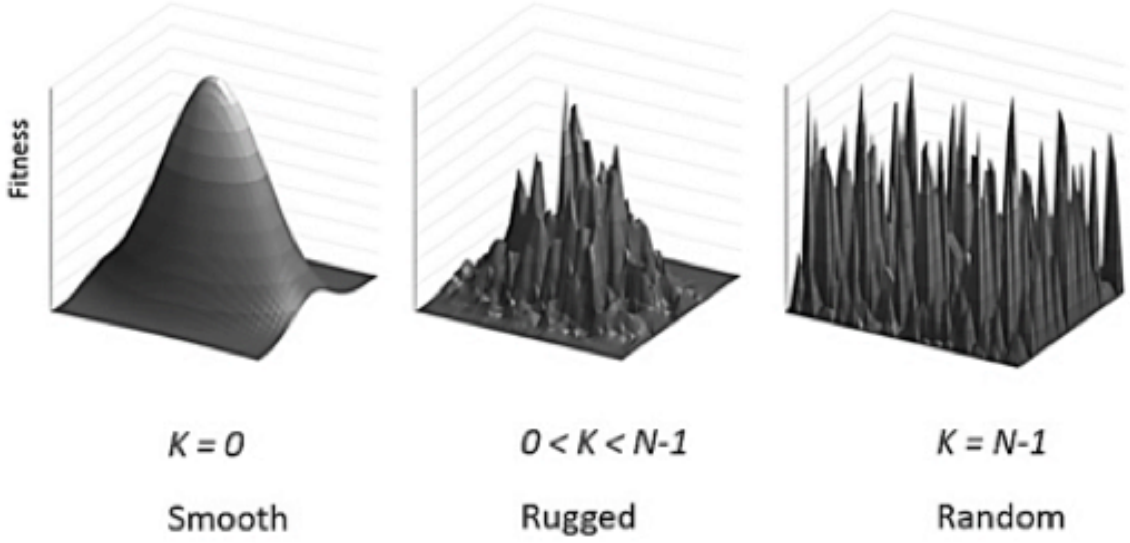
[2] Klick and Parchomovsky cite Alexander (2016), advocating the legislation as an unalloyed good, which in turn cites other pro-legislation voices and literature.

Figure 1. Bundle of Rights with *N=8* and *K=2*



Why does this matter? When we are selecting a bundle, whether by trial and error or a more consciously directed process, the evolution of the bundle will be very different depending on whether these interactions are absent, present, or ubiquitous (Alston & Mueller 2014, 2245, citing Kauffman 1995, 170-76).

Figure 2. Change in Landscape as *K* Increases



These possibilities are depicted in three so-called fitness landscapes, familiar from evolution. Moving from left to right, we get different landscapes depending on whether the rights interact not at all ($K = 0$), somewhat (K is between 0 and $N - 1$), or maximally ($K = N - 1$). The basic idea is that the less interaction there is, the more unequivocally the bundle can be tinkered with to obtain improvements, depicted as fitness on the vertical axis. In the no-interaction case on the left, we can basically tinker our way up something that looks like Mount Fuji (a famously smooth mountain), up and up. Each time we make a positive change we need not worry about it making anything worse in the rest of the system. This is in essence the conventional bundle-of-rights picture. On the righthand side, where every right interacts with every other, the landscape is super jagged: make a small change and all sorts of things bad or good might result. In the middle is a system that is complex but not fully interactive; perhaps it has some structure ("organized complexity" rather than "simplicity" or "disorganized complexity," in the terms of Weaver (1948)). Alston and Mueller (2014, 2267-68) attribute this view of the situation to me, and I concur. This is the territory where the law actually lives. We can tinker with one part of the system and some things will change but in a somewhat predictable way. We're also not guaranteed to get to the best outcome by any pathway. This interconnectedness is an important source of potential unintended consequences. It is also a reason that we might be stuck on a local maximum from which small changes will not get us to a higher maximum; in such situations, we must ask whether larger leaps are worth the risk. An example could be the need to reconfigure a commons with many interlocking rights or a fragmented set of holdings above a pool of oil and gas. Moreover, some solutions will be more stable than others, and can be perturbed by minor changes. We consider this possibility when examining how robust C&M's liability rules are to feedback from opportunistic actors looking for assets undervalued by the legal system. All of these problems arise because of the interconnectedness of the "sticks" in the bundle. The better we understand the epistatic couplings and the resulting fitness landscapes, the more easily we can make reforms that will do more good than harm.

This brings us to the heart of the problem: the complexity of the system. A complex system is one in which many parts interact strongly such that it is difficult to infer the properties of the whole from the properties of the parts. Complex systems theory includes notions of adaptation, feedback, input-output, and self-reference. Systems that are broken up into components or modules are often easier to use – they manage complexity better – as reflected in the middle fitness diagram above. In the first instance, systems considerations caution against oversimplifying our economic analysis of the institutional structures of the law. More generally, complex systems theory has developed empirical strategies for these kinds of systems, which may inspire similar work in the law (Miller & Page 2007, Mitchell 2011). Looking at a system – like property – *as* a system allows for both holism and analysis at the same time. We can connect the macro with the micro.

If the set of interactions of relevance to the law has some structure (it is organized complexity), this can be reflected in the law in order to optimize information costs (Sichelman & Smith 2017). Legally relevant interactions may show community structure: using network algorithms we can detect clumps of interacting nodes and their interactions, which are internally

intense and relatively sparse in between such communities.[3] If so, the law can be modular: law structures interaction so that some information is hidden in modules in which interaction is intense and where the modules only communicate in stylized ways.

For example, in property, a major contributor to modularity is the notion of a thing and the exclusion strategy built on it (Smith 2012). Treating a resource as a thing allows for intense interaction on the inside and stylized more limited on the outside (interfaces). Inside, are all sorts of "epistatic" connections, in the terms of Figures 1 and 2. The liberty to farm interacts with the right to draw water from the ground and both interact with the power to permit entry, etc. Outside the thing, from the point of view of a duty bearer, one need not know what the owner of land or a car is doing or who that person is in order to avoid violating the rights of owners or possessors (e.g. Penner 1997, 71). Sometimes the law will keep these interfaces simple, as in the law of possession, which uses salient and easily understood signals (Rose 1985, Smith 2003, Ellickson 2011). Likewise, basic property forms are standardized because the potential information costs on impersonal and socially distant duty bearers would otherwise be uselessly high (Merrill & Smith 2000, Smith 2003). Again, there is no point for a potential thief or tortfeasors to have to know much about the "internal workings" of other people's property.

There is some irony in how the Realists adopted a picture of the bundle of rights in which sticks are by contrast *detachable*, which leads to the fitness landscape on the left in Figure 2. To the Realists, "context matters," which might imply on the contrary that the correct picture is on the right in Figure 2: everything is relevant (at least in principle) to everything else. Instead, context matters sometimes – for any element some other elements are relevant and many are not. When dealing with such a system, we want context to count where it counts. Where it doesn't, we should welcome a degree of formalism – understood as relative invariance to context (Heylighen 1999, Smith 2003). For example, context matters more to interpretation in natural language than in computer languages, and in natural language context matters more in intimate social settings than in more impersonal situations. The language of mathematical proofs is more formal than everyday working notation. And some aspects of law (e.g. trespass, deed interpretation) are more formal than others (e.g. nuisance, contract interpretation). Modular structures are somewhat formal in this way: they manage complexity by allowing some information to be hidden within the module. Again, brake systems on cars need not interact with the windshield wipers. Context matters sometimes, and we'd like to know when and why.[4]

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[3] Sichelman and Smith (2017) extend the technique in Newman and Girvan (2004) of divisive clustering for locating "communities" (i.e., modules) within a network. We take basic disaggregated legal relations like rights to use and then ask how they cluster, by removing edges with highest "betweenness" – i.e., edges that lie "between" rather than "within" communities – to locate modules, recalculate and remove again. In this way, one can determine the overall modularity of the system, Q, which is the difference between the number of edges within the emergent groups and the expected number in an equivalent network in which edges were placed at random.

[4] The modular structure can even be found in the law of torts, despite its apparent complexity (Smith 2011a). Traditional doctrines for which Realists and their successors had little use can be seen as devices for managing information, by making decisions depend on only some contextual information, and crucially, by making party decisions less interdependent. Thus, for example, some economic analyses of two-party interactions such as accidents make behavior highly interdependent and therefore information-intensive (Bayern 2010). Despite the economic case for decisions to be "correct" on the margin, including their dependence on others' activities (Cooter 1985), the law typically truncates the decisional factors (Anderson 2007; Smith 2011a). Moreover, the decisions asked of an actor and the duties that are organized around them sound in everyday local forms of morality – again the stuff of traditional law that has received a less than sympathetic hearing from most legal economists (e.g.,

One would think that the law would be the prototypical complex system. And yet, for a variety of reasons not least of which is a felt need for tractability and flexibility, the economic analysis of law systematically downplays the systematic aspect of law.[5] And it is this systematic aspect of law that helps explain – sometimes – the traditional doctrines of the law that Legal Realists professed to find puzzling.

III. Liability Rules for a Complex World

Among the fruits of the C&M framework is an unexpected puzzlement about long-accepted aspects of the law. The C&M framework and traditional law can be contrasted in four related ways. In each case, the C&M framework admirably reflects the kind of Realist-style factors that feed into the economic analysis of law and suggest insights against an ideal baseline. This is economic analysis of law. It is the addition of considerations of complexity that point the way toward a more Calabresian and more realistic law and economics.

In C&M's framework, two decisions generate four possibilities. We "must" decide whether to place the entitlement with one party or the other and whether to protect the entitlement (in whichever party it resides) with a property rule or a liability rule. Take a nuisance dispute. The entitlement could be in the resident. If it is protected by a property rule, typically meaning through an injunction, then C&M label this Rule 1. If the entitlement to be free from the irritant is in the resident but only protected by a liability rule, then we have Rule 2. Normally this would mean that the resident could get compensatory damages but the pollution could continue. The polluter could "take the entitlement" for an officially determined price. Now the basic choice of entitlement placement could have been the opposite (think Coasean symmetry). If the entitlement is in the polluter, then we have Rule 3. More in a moment on what that actually means. C&M do mention that Rule 3 involves the polluter being able to continue polluting without the resident being able to invoke the law to force the polluter to stop polluting. Finally, and most unexpectedly, the polluter could have the entitlement but only protected by a liability rule. Here, in the famous Rule 4, the polluter can pollute but would have to stop if the resident pays officially determined damages in the amount of the polluter's cost of shutting down (generally the harm to the polluter from not being able to pollute). Strikingly, at around the same time, in the coming to the nuisance case of *Spur Industries, Inc. v. Del E. Webb Development Co.*, 494 P.2d 700 (Ariz. 1972), the court conditioned an injunction against a smelly feedlot on the payment of its shutting-down costs by the developer of a new nearby senior subdivision.

The two-by-two matrix gives rise to interesting implications for information. As C&M note, a property rule is less informationally demanding on courts, which is why they hypothesize that it is the presumptive remedy in low-transaction-cost settings. And in a side glance at

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Coleman 2001, 16-27). Perhaps even notions of ordinary care in negligence fit this pattern, and through complexity we have a functional and even economic reason not to think that "reasonableness" in negligence is synonymous with cost-benefit analysis (Zipursky 2007, 2013-26, 2029-40; Goldberg & Zipursky 2017).

[5] A somewhat parallel development towards systems thinking in corporate law can be seen in the Realist-inspired nexus of contracts view being supplemented with a greater appreciation of the property-like asset partitioning features of organizational law (Armour & Whincop (2007); Hansmann & Kraakman (2000, 393-94)).

Calabresi's other writing, a strict liability version of damages can be regarded as less demanding in some ways than negligence, which requires a knowledge of both harm and prevention cost (Calabresi & Hirschoff 1972; Polinsky 1979). Which circumstances make these propositions true is not the immediate concern here. It is worth noting that the subsequent literature has expanded the domain in which liability rules are preferred, even at (I would argue) the cost of more complicated systems. (Examples would be ascending auctions and dual-chooser rules, see Avraham 2004; Ayres 2005.)

A. The Nature of Entitlements

First, C&M speak of "property rules," but the content of rights is captured in the thin notion of entitlement rather than traditional notions of property. An entitlement is any right to insist on a given conflict being resolved in one's favor. It can be thought of as a minimal stick in the bundle of sticks. So in Coasean fashion, one can have the entitlement to let one's cattle graze or grow trample-free crops, and one can have the entitlement to be free from pollution or to pollute. And yet the law does not always isolate entitlements in this fashion. Again, the picture of property is more like the middle "organized complexity" version of the bundle in Figure 1 with the corresponding rugged fitness diagram in Figure 2 (see also Alston and Mueller 2014). Instead, property affords lumpy rights to things, in part for reasons of information cost and in part because such entitlements are highly interdependent.

The C&M framework also reflects Coasean causal agnosticism (Merrill & Smith, 2001). In Coasean fashion, C&M see both sides of a nuisance (polluter and resident) dispute as causing the interaction, and yet the symmetry depends on looking at the conflict as one of a thin entitlement only covering the conflict in question. In the hypothetical zero transaction world treating every possible action as being the subject of a separate entitlement (a stick) would be costless. Although it is often forgotten, one of the implications of a positive transaction cost world is that the entitlement structure itself is costly and some structures are more costly than others.

So it should come as no surprise that the thinness versus lumpiness of entitlements is a key design question in the law. Overly thin entitlements require the law to track the interactions between entitlements. Thus, consider what property law would look like if full property (e.g. the fee simple) were delineated by aggregating a set of use rights (like easements). This would require extra delineation of each use right, whereas a fee simple-like property right can leave most of this delineation implicit (i.e. rights or liberties to use protected by a right to exclude refined through mutual accommodation between neighbors through nuisance). Moreover, returning to the evolutionary model above, the method of synthesizing the bundle of rights from thin entitlements requires us to adopt one of two unappealing (and unnecessary) alternatives. On the one hand, one could bite the bullet and track all the connections between the entitlements, but this would lead to high transaction costs and even computational intractability. On the other hand and more likely, the synthetic bundle picture leads to an often highly erroneous (and unrealistic) assumption that such connections don't exist (the lefthand Mount Fuji" fitness landscape in Figure 2.

One way or another, high transaction costs (in the sense of institution costs) leads us to somewhat lumpy entitlements in the real world, which undermines the strong symmetry assumptions behind the C&M framework. For the very reasons C&M invoke for evaluating remedial rules – efficiency, fairness, and other justice reasons – the law implements "entitlements" through lumpy rights, including rights to things in property law (Fennell 2012; Smith 2004b; Rose 1997). However, this necessary choice to group entitlements together (for example, in the default package of rights to "things" in property) *breaks the symmetry* between right holder and duty bearer. Again, the rights protected by trespass and nuisance – a presumptive right to prevent invasions with adjustments along various use margins can be turned inside out only with great disruption to the rest of the system: a presumptive right to commit invasions with adjustments for particular uses. This dovetails with moral views of the situation: we think of rights of bodily integrity which are the opposite of something like slavery and it is somewhat odd to speak of an entitlement not to have one's nose punched that could be (re)assigned to someone as a right to punch one in the nose. Entitlements for C&M are as reversible as the conflicts that underlie them, and symmetry in who gets the entitlement is what lends the framework its much of its theoretical elegance. However, when it comes to actual entitlements, symmetry is the first thing that positive transaction costs (not to mention moral considerations) eliminate as a practical possibility. The more aggregated entitlements we find cannot be as easily reversed. The lumpiness breaks the symmetry of the conflicting parties: invasions or interferences with the thing are presumptive violations. Further, these rights tend to reflect basic morality, which is anything but causally agnostic or blank-slate-style symmetric (Merrill & Smith 2007).

This lack of symmetry and the thickness of entitlements matters most when it comes to the status of Rule 3, the protection of the "entitlement" of the polluter through a property rule. It looks like a "right to pollute." Is there a right to pollute? One can have an easement to pollute, but this requires a grant or prescription. What we exactly don't find is a right to pollute as part of the default "full" package of rights in land (fee simple). When C&M say that the polluter might have the "entitlement" to pollute, they mean that the resident cannot get an injunction – "case dismissed," in Michelman's (2005) formulation. But what if the resident were to use giant fans to blow the pollution back, in a form of self-help (Smith 2004a, 2005)? Could the polluter sue? In the real world, the answer is no, unless the polluter has an easement. If the polluter does not have an easement, then there is no symmetry to the Rule 1 versus Rule 2 scenario. In Rule 1, the resident has a Hohfeldian claim right to insist on no pollution along with a range of other invasions (Hohfeld 1913, 28-32). In C&M's Rule 3, the polluter may have a Hohfeldian (1913, 32-44) privilege to pollute: he can't be sued. But he has no right to pollute either, because he can't get an injunction to shut down the giant fans. The rights structure breaks the symmetry, and if we're talking about the default packages of rights, Rule 3 is not on the same Hohfeldian footing as Rule 1.

B. Rule 4

This lack of symmetry when information costs are high leads to a second difference between the C&M framework and full-blown Calabresian law and economics. C&M famously and dramatically derived Rule 4: given a choice of who to give the entitlement and how to protect it (liability rule or property rule), we get four choices – including giving the entitlement

to a polluter protected by a liability rule and allowing the pollution victim to buy out the entitlement. This is Rule 4. Recognizing that appellate cases have not – except on one occasion – implemented such a Rule 4 solution, Calabresi (2016, 185 n.51) cites procedural difficulties as the reason we don't see them. And yet we do have methods of aggregating litigation that could feed into a Rule 4 situation. We also don't see Rule 4 in coming-to-the-nuisance cases involving only two parties either. Is there another reason for the lack of Rule 4 in the case law?

The problem for a "law and economics" version of Rule 4 grows out of the thin entitlement view taken by C&M. The purpose of Rule 2 is to soften Rule 1 in the context of robust thing-based entitlements. Indeed, there is a range of situations in which enforcing robustly a right to a broad package of entitlements causes disproportionate hardship; building encroachment cases would be a prime example. Once a building is mistakenly built over the boundary, it seems too harsh to enjoin the good faith builder to tear the building down. Disproportionate or undue hardship is the traditional equitable defense to an injunction, and it was a well-known equitable defense to injunctions that was mangled in the "liability rule" opinion in *Boomer v. Atlantic Cement Co*., 257 N.E.2d 870 (N.Y. 1970) (Laycock 2011).

The relationship between Rules 3 and 4 is different from that between Rules 1 and 2 in such a way that the rationale for Rule 2 does not carry over into Rule 4 scenarios. Unlike with Rule 1's protection of the resident's rights to repel a range of invasions, Rule 3 does not involve a robust right to commit invasions, so there is nothing to "soften" through Rule 4. If there happened to be a narrow entitlement to pollute in the form of an easement, it is likely that that targeted device already reflects a "solution" to the conflict, perhaps even a bargained-for one, which does not need further tinkering either.

Thus, if Rule 2 reflects a refinement of a basic exclusion strategy that may be overinclusive in certain situations (e.g. undue hardship), there is no inverse-exclusion strategy – a presumptive right to commit invasions – that needs an inverse-softener like Rule 4. The law does not go through the looking glass. Calabresi may well be right that Rule 4 does come up in a variety of contexts, but basic property law isn't one of them. And the reason why it isn't relates to property law as a modular system with refinements – exclusion and governance.

C. Opportunism as Feedback

Complex systems theory leads us to worry about feedback effects, and the literature building on the C&M framework pays too little regard for the possibility of feedback. Assuming away feedback in the form of system-abusing or system-altering strategic behavior is a fundamental problem with the economic analysis of law. Indeed, in Calabresian law and economics fashion, the law here suggests the pervasive impact of strategic behavior on remedies and entitlement structures.

The economic analysis of law often makes assumptions about the underlying probabilities of activities and events. Activities and events are treated as stable (with stable mean values) in part because this makes modeling behavior in expectation easier. This suite of assumptions is sometimes termed "neo-actuarialism," in which one assumes that institutional designers and actors can treat activities and events in groups that have some probabilistic

stability (Ortiz 1994). Thus, when it comes to internalizing externalities, a staple of economic analysis of law, the idea is to charge an actor with expected harm. When the actor is making decisions, expected cost can be compared with expected benefit, as is appropriate ex ante.

The economic analysis of law treats situations in which the activities of individuals cause a market failure as an exceptional departure from this mode of analysis. Thus, asymmetric information can cause a market to unravel: in the prototypical illustration of a used car market, buyers only know the average value of a used car and so will pay no more than that amount, leading sellers of above average cars to exit the market, and leading in turn to average quality growing down, etc. The "market for lemons" can unravel (Akerlof 1970). Various institutional devices such as reputation, warranties, and information suppression can help prevent these kinds of effects (Barzel 1982). Another way to put the point about internalizing externalities is that unraveling should not be assumed away in the most basic context of externality internalization.[6] Not only is it a problem with certain markets, asymmetric information is central to the entitlement structure.

Consider liability rules in terms of asymmetric information. If we assume away the problem, the probability distribution of activities, say of committing a nuisance or the level of "taking of entitlements," is stable, and liability is much easier to assign. If courts assign a liability level they need not do it correctly in all instances. As long as they get it right on average and error is symmetrical, the regulated actor faces the correct incentive in expectation. Thus, if liability is set at average harm, the liability in expectation is equal to harm in expectation, leading to internalization of the harm (Kaplow & Shavell 1996). On this view, aside from risk aversion, second-best, and suchlike considerations, actors will then generally act consistently with efficiency.[7] If so, liability rules have a built-in advantage over property rules, which on conventional economic analyses of law require the one "setting" the entitlement to know where it is most valued, lest transaction costs prevent it from finding its most valued use.[8]

Turning back to liability rules, we need to ask what effect strategic behavior by opportunists, i.e. those exploiting asymmetric information in ways hard to capture with regular legal rules, might have on the operation of a system of extensive liability rules.[9] As in other

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[6] What the underlying "thing" is that is the subject to the entitlement can also change in response to legal rules, as where a mandated product warranty might under certain conditions lead to lower quality along nonregulated dimensions. (Smith 2000, see also Barzel 1976).

[7] Whether and to what extent to include such factors in the economic analysis of law has been controversial as have more recent supplementations of bounded rationality. For example, the law of equity (about which more in Section III.C) may be responsive to different individual motivations and moral priming (Feldman & Smith 2014). The argument here is that very basic systems considerations point in a different direction than the usual import ascribed to the C&M framework.

[8] Interestingly, attention to the possibility of unraveling through asymmetric information makes ex post evaluation through legal rules looks better and causes efficiency and moral accounts to converge. (Gold and Smith 2016). I leave these bigger threads for another day.

[9] I invoke opportunism, not because opportunism is inconsistent with rationality combined with asymmetric information, but because a category of such behavior appears to pose a problem for "first order" legal rules and invite a response by "second order" interventions that operate to change the result that first-order law would

areas, opportunists know a lot about the system and can exploit its weakness. Here an opportunistic taker might cherry pick which entitlements to take (Smith 2004b, 1774-85). A taker might know that an entitlement is likely to be undervalued by a court, perhaps because of the proxies the court uses, evidence a court will not entertain, or other reasons that the entitlement holder cannot prove damages. If the taker could benefit from the taking more than she would have to pay in (undervalued) damages, the taker will take. This could be especially true in the case of parcels of land: consider someone who thinks there will be future demand for a given parcel as a nature attraction. Here an entitlement protected by a liability rule would move the entitlement to a lower valuing user.[10] Conversely, if an entitlement is overvalued, a taker will not take. Thus, the cases that face the court are not "average harm" cases, and even if they were, a focus by takers on undervalued assets is likely to keep changing the background probability distribution, creating systematic error and destroying the correct-in-expectation feature of liability rules (Smith 2004b; see also Barzel 1982, 28-32).[11]

These feedback effects from opportunism actually strengthen a rule of thumb that C&M proposed and that has come in for some criticism. C&M themselves (1972, 1106-10) proposed that property rules are preferred in low transaction costs settings and only situations of high transaction costs would call for liability rules. Later commentators have argued that liability rules possess a wide informational advantage (e.g., Ayres 2005). As we have seen, the idea is that courts need only know the expected average harm or some other variant, which then can be charged as liability. Opportunism changes the picture: the property rule may be less susceptible to opportunistic feedback. C&M (1972, 1124-27) were right to hypothesize that property rules are used to protect the law's prescribed transaction structure by preventing takers from converting all rules into liability rules. One way the law does this is to prevent takers from exploiting court error. The problem of feedback can be thought of as a reason supporting C&M's intuition favoring property rules.

The problem of opportunism is two-sided. If property rules mean injunctions, then we must worry about the opportunism of entitlement holders in the form of hold-out and the opportunism of arbitraging takers. This is familiar in the context of building encroachments, in which it makes a big difference whether an owner is extorting the trespasser after a minor innocent mistake or an encroacher has built over the boundary deliberately. The problem of potential two-sided opportunism arises in patent law as well: is a patent holder holding up an innocent infringer or is an infringer opportunistically lowballing and stringing along a patentee?

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otherwise produce. For example, unconscionability can be treated as a problem that invites an override of ordinary legal results, and a suspension of enforceability of contracts (Smith 2017).

[10] This opportunism can be a problem regardless of how the new entitlement holder is protected. The process of taking or actions taken soon after may make the resource unsuitable for the original owner's purpose. Or the prospect of takings may erode the incentive to develop the information about future demand in the first place. Recent work suggesting that property rule protection is less warranted or warranted for reasons of myopia tend to overlook the role that remedies pay in protecting the complexity-managing function of entitlement structures (Bar-Gill & Persico 2016, Posner & Weyl 2017).

[11] In a sense the Lemons-like feature of the interaction causes a macro effect on the liability system (Akerlof 1970; Schelling 1978). This type of problem is also what complex systems theory concerns itself with.

The problem is compounded by the greater difficulty of giving notice of patent rights and the corresponding difficulty in deciding what is a willful infringement. Thus, among the potential solutions are greater use of damages (Lee & Melamed 2016) or greater use of equitable doctrines like undue hardship, estoppel, and unclean hands (Smith 2013). Which approaches are warranted is an empirical question, but opportunism on either side cannot be reasoned away in an a priori fashion.

More generally, equity, which traditionally policed the decision between injunctions and damages, developed doctrines like disproportionate hardship and something like abuse of right in order to deal with potential opportunism on both sides. I have argued elsewhere that a main function of equity is to solve certain problems of high variability and uncertainty by providing law about law, or meta-law (Smith 2015, 2017). In the case of opportunists, we may need this second level in order to take as broad a view of the problem as the opportunists and to gain the advantage of acting against them ex post. The C&M framework brings out how the system of remedies is vulnerable to abuse and calls for employment of the equitable function. Attention to the actual legal details, such as the role of good faith and the possibility of shifting presumptions, can show how the field of remedies has implications for economics (Gergen, Golden & Smith 2012, Bray 2016; see generally Bray 2017).[12]

D. Broader Considerations

Adding system effects to the C&M model is important not just for accuracy. It also carries implications for how we interpret the choice of property rules and liability rules. Calabresi (2016) extends some recent thoughts in Calabresi (2014) about how the choice for liability rules should not be taken too narrowly. First of all, in no way does viewing private law as a complex system detract from the need to set it in a larger context of societal values and choices. And yet there is a danger that if one ignores the system considerations that may be in play in the choice of property rules and liability rules (and inalienability rules), one can jump to the conclusion that a device needed to prevent very specific forms of abuse of the system (e.g. by opportunists) reflects a societal choice for social democracy over socialism or libertarianism. Maybe. We simply can't evaluate such sweeping pronouncements until we know the range of possible explanations. When it comes to property in particular, theorists tend to see struggles over fundamental values at the level of specific doctrines. It may be that with a wider view to what counts as a functional explanation, efficiency and moral accounts converge on some of these doctrines (Gold & Smith 2016). Sometimes this convergence won't happen, and even after it does, we still face foundational issues concerning why we have property in the first place. We can't know where the grounds of dispute lie until we have an accurate picture of the system as a system.

Calabresi's lessons from liability rules for society at large need to take account of complexity as well. The choice of liability rule or property rule might turn on the solution of a

[12] Moreover, a system of property rules implemented through the traditional equitable standards is not only robust to feedback in the forms of opportunism. Equity allowed for the legal system to learn and adapt: equity picked up on and responded to new forms of fraud, and its institutional responses would sometimes eventually make their way into the common law itself (Smith 2017).

potential two-sided opportunism problem. Here the choice between liability rule and property rule will turn on party behavior and might do so whether the general tenor of the system is collectivist, libertarian, or social democratic. In other words, sometimes – and only sometimes – what Calabresi sees as the resonance of large social choices may be a response to the feedback in the complex system from opportunists and the like. To sort through which choices reflect which considerations means at least we have to have the potential considerations in view.

IV. Conclusion

None of these considerations detracts from the C&M framework as an outstanding example of the economic analysis of law. However, as law and economics, as an example of an applied field sensitive to the phenomenon to be explained, the C&M framework lacks one thing: the recognition of law as a complex system. So if we're interested in the law as a phenomenon, some of the doctrines and structures that, with the Realists, C&M (1972), the C&M-inspired literature, and now Calabresi (2016) are inclined to dismiss as formalist baggage might themselves be serving some function. None of this is a blanket apology for the world as it is – certainly not the one the Realists have created. Rather it is a plea for a better functionalism.

This is an optimistic story. Adding complexity to the picture makes the C&M framework more suitable for true law and economics. Complex systems theory allows us to capture something about the law missing in the conventional economic analysis of law. If there is one thing that characterizes Calabresi's vision of law and economics it is the ambition to connect the details with a sweeping vision of society, combined with an appreciation of complexity.[13] Taking the law seriously as a complex system can make Calabresian law and economics more Calabresian.

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[13] Complex systems theory allows one, in Herbert Simon's (1981 [1969], 195) words, to be a an "in-principle reductionist and a "pragmatic holist." That's what Guido is. Or is it the reverse?

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