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ENTROPY IN PROPERTY

ABSTRACT: The title of this article suggests that property is subject to a fundamental law of entropy, namely that it is affected by a one-directional bias leading towards increasing fragmentation. The application of the laws of entropy to property further indicates that one can avoid this tendency only in the purely abstract world of zero transaction costs. Building upon this consideration, I consider the choice of remedies in property law, focusing on legal rules that are designed to promote (a) functional, (b) legal, and (c) physical unity in property. I provide examples drawn from both common law and civil law systems, supporting the hypothesis that legal rules are instrumental in combating entropy in property.

Legal historians occasionally overlook the existence of the economic forces that account for the historic evolution of law. While we have a relatively well developed record of the historical transformations and comparative variations in the law of property, we tend to give only marginal consideration to the important dynamics that determined such transformations and differences. In this paper, I wish to provide an economic theory to explain some of the apparent anomalies in the evolution of property law.

Building upon the recent literature on property fragmentation (Heller, 1998; Buchanan-Yoon, 2000; Parisi-Schulz-Depoorter, 2000) this article suggests that property is subject to a fundamental law of entropy.[2] In the property context, entropy induces a one-directional bias

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[2] I am using this term to refer to the second law of thermodynamics, according to which every process that can occur spontaneously will go in one direction only and will result in a release of energy that cannot be recaptured, so that the amount of entropy in the universe will continually increase.

which leads towards increasing property fragmentation. The laws of entropy further indicate that only in the purely abstract limited case of (both internally and externally) reversible transformations will the overall net change in entropy be zero. As applied to our property context, this further indicates that only in a world of zero transaction costs would there be no such tendency towards fragmentation.

The economic forces that induce entropy in property are quite straightforward.[3] Property division creates a one-directional inertia: unlike ordinary transfers of rights from one individual to another, reunifying fragmented property rights usually involves transaction and strategic costs higher than those incurred in the original deal.[4]

The comparative and historical analysis of the law of remedies offers a fertile ground for examining the role of legal rules in minimizing the potential welfare losses resulting from the impediments that force certain transactions to be unidirectional. This paper revisits the implications of the normative Coase theorem (e.g., Calabresi-Melamed, 1972; Ayres-Talley, 1995; Kaplow-Shavell, 1996) and considers the choice of optimal rules and remedies to combat entropy in property. I formulate an efficiency hypothesis, suggesting that legal systems address problems arising in a positive transaction cost environment by developing rules that closely approximate the results the parties would have reached in a zero transaction cost world. I compare the ideal choice of remedies

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[3] Heller (1999) cites the fairy tale of Humpty Dumpty to illustrate his point. When Humpty Dumpty is shattered into pieces even all the king's horses and all the king's men can't re-assemble him, which stands in contrast to the ease with which he broke into pieces in the first place.

[4] As in the physical world, where it takes considerable additional energy to roll a rock back up a hill, after it has rolled down on its own, it takes considerable financial and legal effort to reunite property rights that have been split. Parisi-Schulz-Depoorter (2000) observe that even reversing a simple property transaction can result in monopoly pricing by the buyer-turned-seller; reunifying property that has been split among multiple parties engenders even higher costs given the increased difficulty of coordination among the parties.

with the reality of property law. Entropy creates one-directional transactional impediments that explain several apparent anomalies in the law of remedies. This paper formulates an efficiency hypothesis pertaining to property: Given the greater difficulty of reaggregating property once fragmentation is allowed, legal systems adopt legal mechanisms to combat entropy. Furthermore, they provide less extensive property-type (in the Calabresi sense) protection to atypical property arrangements.

Both common law and civil law systems provide examples of this hypothesis, demonstrating its validity in different legal environments.

1. Structural Variations in Property and the Dilemma of Unified Property

In spite of the reluctance of modern social scientists to formulate general theories of evolution, most anthropologists and legal historians would agree on the general patterns that characterize the evolution of property in society from ancient to modern times. All societies recognize private property, to a greater or lesser extent. The content of property and its form of protection, however, has undergone substantial changes over time. The legal evolution of the concept of property reveals a close relationship between changes in an economic system and shifts in the structure and content of property rights. Specifically, property has been subject to the economic laws of entropy, resulting in different forms of property fragmentation throughout history, ranging from functional to physical and legal forms of fragmentation. Nevertheless, human societies have successfully conceived various remedies to ameliorate the irreversible effects of entropy in property.

1.1 From Functional to Spatial Conceptions of Property

In pastoral societies, relatively simple rules governed land ownership. The character of property rights was related to the functional use of the land. For example, those who used the land to hunt could acquire hunting rights and those who raised livestock could obtain grazing rights in the same geographic area. Such functional conceptions of property were the natural consequence of the derivation of property from actual use and possession of the land (Rose, 1985). In short, how the land was used determined the kinds of possession possible.

No single act of possession can encompass all potential forms of land use, meaning that the system of deriving ownership from possession generates limited (or "functional") property rights. This system often resulted in multiple property claims coexisting over the same land. Customary rules then regulated the possession, use, and transfer of such functional rights. Such functional divisions often made good sense because different owners could undertake specialized activities over the same territory with little encroachment on one another.

Given the low population density and the limited rate of exploitation of natural resources, functional partitions of property were indeed often efficient. They provided an opportunity to allocate the same land towards multiple privately held use rights, allowing an optimal level of exploitation, as all parts of the property could be used.[5] Detailed customs, based on past usage and historic rights, determined what was considered acceptable conduct with respect to the interaction (natural externalities) between the various activities. Early societies thus embraced a "functional" conception of property, in which property rights were related to specific uses of the land, rather than a spatial conception of property, in which the confines of property were determined by physical boundaries. Property was not divided along spatial lines, as in the modern world, but through horizontal functional partitions, in which

[5] For an application of this framework to modern settings, see Smith (2000).

different individuals or families would own specific rights over the land related to specific uses (e.g., farming, fishing, hunting, etc.).

As time progressed, however, agricultural societies developed a more complex conception of property in which functional partitions of rights survived as exceptions to a regime of unified ownership.[6] This paradigmatic shift is understandable, given that in an agricultural economy the coexistence of multiple rights over the same land created conflicts and increased opportunities for wasteful externalities. Furthermore, functional partitioning of land, while efficient in a stable economy, became unsustainable in conditions of rapid economic change. Moving from pastoral to agricultural economies, many societies thus changed their property systems, abandoning functional property in favor of spatial property (i.e., making their property systems more similar to those we are accustomed to observing in the modern Western world).

This transition has a plausible economic explanation. With a rapidly changing economy, optimal uses of land are also subject to rapid flux. A functional property regime impeded the transformation of land to optimal use, given the wide range of rights that had to be accommodated or superceded.

In spatial property regimes, a single owner generally holds all rights pertaining to a tract of land. Such unified ownership could better serve the needs of a changing economy. The division of property along functional lines, while allowing the optimization of property with respect to all of its potential uses, did not provide sufficient flexibility to accommodate structural transformations over time.

The Roman law concept of property is thus based on the realization that the optimal use of the land is subject to change over time,

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[6] Absolute property rights can be observed only as an exceptional category in most non-Western societies while they represent a default property regime in modern Western legal systems. Generally speaking, the absolute Western conception of property is not universal, at least historically.

and that absolute ownership rights provide greater flexibility, given the concentration of decision rights in the hands of a single individual.[7]

1.2 Physical Unity and Legal Disunity in Medieval Land Law

The historical evolution of property led to the emergence (and gradual dominance) of "spatial" conceptions of property, with absolute property regimes as the default legal rule in all established agricultural societies. During the feudal era a new array of functional and legal limitations on the use and disposition of land encroached on the Roman conception of absolute property. Although the foundations of the medieval law of property were unquestionably Roman, the feudal system gradually transformed the accepted social conception of property.

In the feudal world, rights and duties were based on land tenure and personal relationships and this conception of property was instrumental in maintaining feudal social and economic structure. The early types of land licenses resembled grants of full ownership, but in later times the kings and the lesser lords kept the ownership of the land to

[7] Obviously, if a single owner can claim tract of land, a different fragmentation problem may take place: excessive spatial fragmentation, leading to inefficiencies of scale. Western agricultural societies dealt with this problem in a variety of ways. In Roman law, the head of the household (*paterfamilias*) had concentrated authority over the property. An elaborate system (*peculium*) mitigated this concentrated legal capacity as with other members of the family group, such as slaves and sons, authorized to make binding legal transactions relating to property. In later times, when legal capacity was extended to every individual of majority age within the group, the fragmentation of property was prevented though other rules and social customs, such as succession rules (e.g., rules of primogeniture), and institutional arrangements (e.g., feudal hierarchies) resulting in the concentration of land in the hands of a few individuals.

themselves and granted only partial rights of use and exploitation.[8] Land was held in *fief* by vassals as a result of a grant by their lords in exchange for a variety of services and vows of personal loyalty.[9] These grants of fragmented ownership gradually became hereditary holdings.[10] Customary norms prevented the unilateral abrogation of these grants, except as a result of legal forfeiture and seizure.[11] This resulted in a multi-layered, and potentially irreversible, fragmentation of property.

In this feudal system of land tenure, each individual was defined by his hierarchical status and relationship to land. With the sole exception of the king, every individual was subservient to another. According to the well-known feudal pyramid, only the lesser tenants had possessory use of the land, and all the others served as intermediaries in the collection of fees and granting of services and protection. The king stood as the ultimate residual claimant. Through this process, feudal property became

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[8] Other privileges of the lord included the so-called feudal incidents, which, among other things, gave the lord right to possess the land.

[9] Over time, the services, which were originally related to supporting and defending the lord in time of war through military service, were gradually converted into pecuniary obligations. It is impossible to understand the developments of medieval society without realizing that the crown and the nobility (and within each major feudal manor the lord and his vassals) were power centers that were always potentially in conflict. The famous feudal pyramid (king, nobility, lords, vassals) depicts a dynamic society that was often on the verge of disintegration. On the personal level, the loyalty agreement between a lord and his vassal always tended to mask that same kind of unstable relationship and, likewise, the property ties attempted to create a bonding mechanism that would foster stability.

[10] If a tenant died without heirs, the land returned to the lord: a form of residual claim of the sovereign that survives, under different name, in the modern law of successions.

[11] Forfeiture and seizure were remedies that allowed the lord to regain possession of the land if a tenant had breached his oath of loyalty or failed to perform the applicable feudal services. Similar remedies applied in the case of high treason in favor of the king. For further discussion, see Chapter 3 of Dukeminier and Krier (1998).

quite distinct from the Roman paradigm of property, as feudal grants were always limited by the act of license and title; possessory interests never resided in the same hands. Property ownership was neither unlimited nor absolute; interests were not enforceable *erga omnes*, but rather consisted of a bundle of rights and duties, partially applicable to the whole community and partially determined by the specific contractual relationship between the grantor and the grantee. A complex system of political and social control reinforced this transition from the Roman system to the feudal regime of dispersed ownership (and property fragmentation).

Feudalism was inextricably linked to agricultural life.[12] In an agricultural economy, functional forms of fragmentation are generally not problematic, as long as the physical unity of land is preserved. In this respect, feudal legal systems were designed to limit the risk of excessive fragmentation.[13] Rules of primogeniture[14] and prohibition of subinfeuds[15]

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[12] The feudal economy was largely based on agriculture. The feudal structure ensured the production of food needed for maintaining a population constantly on the verge of war.

[13] Even the feudal law of property – often presented as the paradigm of entropic property – conceived remedies to combat excessive property fragmentation. Indeed, while some functional forms of fragmentation of property were instrumental to the stability of the feudal society, others could be easily prevented.

[14] In the Western legal tradition, laws forbidding the partitioning of land and establishing the succession to land in favor of the youngest or eldest son have often been utilized to preserve the unity of land. These rules often had customary origins and enjoyed a large degree of voluntary compliance, given the interest of most landowners in protecting the power and prestige of the family, which was traditionally linked to the size of land holdings. In this context, priority in succession was traditionally given to the eldest son (primogeniture) or to the youngest son (ultimogeniture). The principal effect of these rules has been the maintenance of unity in the estate of the deceased.

[15] Rules emerged to prevent the further fragmentation of possessory interests even in feudal times. The tenants in demesne could not subcontract their rights and

are examples of the attempts of feudal law to constrain entropy in property.

The peculiar coexistence of physical unity and legal disunity in feudal property could work in an agricultural economy, but proved problematic in any other kind of economic context. Indeed, feudal arrangements, which generally flourished in closed agricultural economies, did not take root in urban environments.[16] The cities of the Roman empire, in as far as they survived at all, did not have a parallel

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obligations through the creation of a lower rank of feudal agents. The practice of subinfeudation has provided much of the intellectual justification for the modern constraints on functional property fragmentation. Rudden (1987) refer to this idea as the "pyramiding" rationale: if each succeeding owner of a property interest has the power to intertwine the land with the performance of a fancy, then the land will be encrusted with a pyramid of obligations not unlike those that were associated with the practice of subinfeudation. Rudden acknowledges the weight of this argument, but makes three objections. First, he thinks that the historical objection to subinfeudation did not primarily concern the layers of obligation. Second, he thinks that a legal mechanism could check the excesses of a wider system of property interests. Third, market mechanisms rather than legal mechanisms may better solve such pyramid problems.

[16] According to Monateri (1996), it is not coincidental that the rebirth of Roman legal studies began at a time of revival of urban life in northern Italy. Southern France was the center of a code-oriented legal system, as the Roman law remained in force. In contrast, a more complete feudal system in northern France led to the development of customary law under the Carolingian Franks. The cities were not centers of feudal, but rather ecclesiastical, power, so that canon law took precedence, although the merchant law was an important component of the *ius commune* at least in localities with active commercial markets. Parisi and O'Hara (1998) and Parisi (1998) observe that although jurisdictional conflicts were possible, feudal law harmoniously coexisted with the merchant law, given the different focus on property and contract issues (i.e., feudal law generally covered property and status issues, while the latter was mostly dealt with contract and commercial issues).

feudal structure,[17] with the exception of some urban areas in Italy and southern France.[18]

1.3 The Rise of Absolute Conceptions of Property

With the approach of the modern era, came another paradigmatic shift in the conception of property. Just like the transition from pastoral to agricultural economies rendered the so-called functional conceptions of property impracticable, the gradual growth of the economy made the feudal dispersion of control over property highly problematic.

As generally recognized in the literature, the abolition of feudalism was a necessary precondition for the shift to a modern market in land, in which individuals can transfer full ownership and development rights to third parties through contracts or testamentary dispositions. The transition back from the relativistic and contractual basis of property to the Roman absolute conception of ownership, was not gradual and

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[17] The feudal system did not form the base of jurisdiction in cities, where canon and Roman laws took precedence. Feudal law was not congenial to the dynamic needs of the emerging mercantile class. As a result of the commercial revolution brought about by the medieval mercantile class, the large cities of the former Roman empire became attractive localities for the development of active commercial markets, and most second-generation medieval merchants relocated their center of activity in large cities. At this point, the law merchant became an increasingly important component of the *ius commune.* For further analysis, see the interesting book on the law merchant by Galgano (1976).

[18] Feudalism spread from France to northern Italy, Germany and Spain and, later, into some of the eastern Latin territories of Europe. Most of the other great civilizations of the world have gone through periods resembling the feudal arrangements, although the specific characteristics are somewhat different from the typical paradigm of medieval Europe.

smooth, however.[19] The historical events surrounding the end of the feudal era demonstrate the power of the irreversible dynamics of entropy in property, theme of this paper.

Both a political and ideological revolution were required to reshape the dominant conception and content of property. The French revolution marked a critical turning point. In a vain attempt to stave off serious political and social upheaval, the French nobles and clergymen renounced some of their feudal privileges at the first session of the Estates General in over 200 years on August 4th, 1789. The theoretical significance of this action was great, as it freed the land from a multitude of personal servitudes (e.g., hunting rights and labor services). Other feudal burdens (e.g., seigneurial fees) could be extinguished by paying a lump sum amount to the lords (generally corresponding to 20 to 25 times the value of the annuity). In practice, the peasantry was unable to pay the large amounts required to obtain release from the feudal servitudes. The French Revolution itself brought with it the collapse of the feudal regime, with the outright abolition of all burdens and seigneurial fees without compensation.

During the 18th century, it had became fashionable to point to the feudal tradition as the root of the inefficient property fragmentation and to rebel against the feudal heritage by proclaiming a new paradigm of absolute and unified property. Historically, feudal land systems imposed on landholders positive obligations, which were not part of the Romanistic bundle of rights and duties of property holders, mixing absolute and relative rights in a hybrid property relationship. Hegel's (1942 [1821]) philosophical version of this history has influenced the legal conceptions of property around the world. Hegel purports that the standardization of property interests is a movement that is related to the

[19] The feudal property arrangements characterized much of the customary law of property, but medieval academic jurists continued to utilize the Roman categories of property in their scholarly writings. This facilitated the return to the Roman categories that were eventually reinstated as part of the opposition to feudalism that helped lead to the French Revolution.

difficult struggle to free property from the pervasive feudal encumbrances, suggesting that individual freedom closely depends on the freedom of property.[20]

In this setting, the Roman approach became the model for bourgeois property, conceived as an absolute private right to the enjoyment of one's land. This renewed conception is at the origin of much theoretical work in legal theory and philosophy. One can think of John Austin's (1885 [1832]) premise is that the right of property consists of two main elements: the right to use the property and the power to exclude others.[21] Most importantly for our analysis, XVIII and XIX theorists specified the structural attributes of a property right. Among others, we find the Kantian notion universal norms must be negative in content, that is, they "must command individuals us *not* to do something." and that "the correlative of a real right cannot require action...".[22]

This conception of absolute property contrasted dramatically with the concept of feudal property as a bundle of rights and duties that mixed relative and absolute relations in both private and public spheres. Although, in many respects, such a unified conception of property was already present in the pre-feudal world, the intellectual reaction against the old regime led to a more nuanced articulation of this ideal.[23] This

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[20] Rudden (1987, p. 250) keenly points out "the word 'servitude' covers both slavery and easements."

[21] John Austin (1885 [1832], p. 808).

[22] Rudden (1987, p. 249) thinks that these logically relate to Austin's premise, citing Immanuel Kant (1887 [1797], p. 14) in support of these propositions.

[23] Mattei (2000, p. 14) observes that the modern unitary theory of property rights is indeed the intellectual product of the French Revolution. Along similar lines, the extensive work of Rodota (1990) demonstrates the limits of the analogies between the Roman notions of absolute property and the modern restatement of such notion contained in Article 544 of the French Code of 1804. For further historical analysis of this important transition in the conception of property, see Monateri (1996).

theoretical evolution culminated in the revolutionary events of the 1790s that marked the beginning of a new era in the property regimes of France and the rest of Europe. This new legal approach, in order to meld successfully the concepts of functional unity with the revived absolute conception of property, had to have substantive rules to foster functional, physical, and legal unity in property. These principles of unitary property are embodied in several important rules that characterize modern property law, which we shall consider next.

2. The Rise and Fall of the Modern Ideals of Unified Property

As a reaction to the feudal tradition, the Rationalist jurisprudence of the 18th century and the modern codifications of the 19th century revived the various important Roman rules of property, recasting them as general principles of civil law. The principles of unity in property can be tentatively grouped under the headings of (i) functional, (ii) physical, and (iii) legal unity. These related principles contribute in different ways to control the problems of entropy in property.

2.1 Principles of Functional Unity in Property

Under classical Roman law, the property owner (*proprietarius*) was not allowed to transfer anything less than the entire bundle of rights, privileges, and powers that he had in the property. Conveyances of rights in a lesser measure than full ownership were only permitted on an exceptional basis and in a limited number of cases.[24] Thus, for example, the creation of legally binding restrictions on property was limited to

[24] Thus, for example, use and exploitation rights divorced from ownership (*usufructus*) could be given only to a living person for the duration of his lifetime; the creation of legally binding restrictions on property (*servitudes*) was sharply limited.

situations in which the dominant estate could demonstrate a perpetual need for the arrangement. In the Roman Digest we read that servitudes necessitate a *causa perpetua*.[25] In other passages, the Roman sources explicitly indicate that the servitudes created for the transitional benefit of the owner of a neighboring lot (as opposed to the perpetual benefit of the land itself) were not valid. [26]

As we have discussed above, this notion of absolute ownership underwent a substantial change in feudal law, but eventually regained popularity at the time of the modern European codifications. The modern codes limit the permissible level of functional property fragmentation and further provide property-type protection only for specific, socially desirable, property rights.[27] This favoring of certain property arrangements is known as the *numerus clausus* principle and is an important expression of the fundamental principle of unity that underlies modern property law. The purpose of this principle is to forestall private individuals from creating property rights that differ from those that are expressly recognized by the legal system.[28]

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[25] Paulus Book 25 *ad Sabinum* in D. 8.2.28: "omnes autem servitutes praediorum perpetuas causas habere debent" (all servitudes must have a perpetual cause).

[26] Paulus Book 15 *ad Plautium* in D. 8.1.8: "ut pomum decerpere liceat et ut spatiari et ut cenare in alieno possimus, servitus imponi non potest." (Servitudes cannot be creates to grant rights for harvesting fruit or to have meals or merely to walk on another's property) Such atypical arrangements – it was understood as an implicit corollary – could however, be created as a matter of personal obligations.

[27] European scholars also refer to this principle by invoking the concept of *nominate* property rights. Merrill and Smith (2000, p. 69) have recognized that, although the *numerus clausus* principle is mostly a Roman law doctrine followed and enforced in most civil law countries, the principle also exists as part of the unarticulated tradition of the common law. The authors illustrate the many ways in which common law judges are accustomed to thinking in terms comparable to the civilian doctrine.

[28] For a modern challenge to the *numerus clausus* principle, see Rudden (1987) who critically analyzes the legal, philosophical, and economic justifications for limiting the types of legally cognized property interests to a handful of standardized forms.

The early formulations of the *numerus clausus* lacked a well-articulated rationale, especially striking because it contrasts sharply with the doctrine of freedom of contract, namely that two parties to a private contract may agree on virtually any arrangement without government limitations.[29] The dichotomy between these contract and property paradigms results in a general tension between the principle of freedom to contract and the societal need for standardization in property law. The modern European codifications all reflect this tension. They promote freedom of contract by recognizing and fully enforcing, both *nominate* and *innominate* forms of contract. Yet at the same time they limit private autonomy in property transactions and only enforce transactions pertaining to standardized (or *nominate*) forms of property.[30]

Although in many ways the intellectual product of the French revolution, the influence of the *numerus clausus* principle has lasted well beyond the post-revolutionary codes, and can be found in most of the modern European codes. The Napoleonic Code of 1804,[31] the German

[29] Merrill and Smith (2000, pp. 68-69) note the peculiar dichotomy between property and contracts, observing that while contract rights are freely customizable, property rights are restricted to a closed list of standardized forms.

[30] This implies that property rights are only enforced with real remedies if they conform to one of the "named" standardized categories. Conversely, the presumption is the opposite in the field of contracts: the legal system enforces all types of contracts unless they violate a mandatory rule of law concerning their object and scope.

[31] Several articles of the French Civil Code embrace the concept of "typicality" of real rights and articulate principles of unitary and absolute property. See, e.g. Article 516 on the differentiation of property; Article 526, enlisting the recognized forms of limited real rights (usufruct, servitudes and mortgages); Articles 544 - 546 on the definition and necessary content of absolute ownership, etc.

BGB of 1900,[32] and several other codifications[33] contain provisions that restrict the creation (or at least withhold the enforcement) of atypical property rights. As Rudden (1987, p. 243) aptly put it, "in very general terms, all systems limit, or at least greatly restrict, the creation of real rights: 'fancies' are for contract, not property."

These limits on the creation of atypical property rights eventually emerged as a general principle of modern property law. Even jurisdictions that have not formally codified the doctrine adhere to its strictures.

The requirement that the transfer of immovable property be recorded in a public registry enforces the *numerus clausus* principle because only nominate property rights can be duly registered, thereby ensuring the intelligibility of public records for notice and publicity purposes.[34] It follows logically that any contract which constitutes or

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[32] BGB Paragraph 90, by providing that "Only corporeal objects are things in the legal sense" can be seen as a substantial departure from the feudal conception of property, where most atypical rights were had a nontangible nature.

[33] Practically all important modern codifications – not all of which were directly influenced by the French and German models – embrace a similar principle of unity in property. Rudden (1987) provides a comparative survey of the *numerus clausus* principle in the modern legal systems of the world, reporting that many Asian legal systems have adopted a basic rule according to which 'no real rights can be created other than those provided for in this Code or other a legislation' e.g., Korean CC 185, Thai CC 1298, and Japanese CC 175. Similar provisions exist in other systems of direct European derivation such as Louisiana CC 476-8, Argentine CC 2536, Ethiopian CC 1204 (2), and Israeli Land Law 1969 sections 2-5.

[34] The "absence of notice" legal rationale purports that it would be difficult for a purchaser to know about "fancies", or non-*numerus clausus* property interests. Rudden (1987) objects to this rationale. He thinks that a functioning recording system could reveal fancies to a purchaser. Further, notice is neither necessary nor sufficient, to create valid property interests. For further analysis of this point, see Mattei (2000, pp. 91-92), who observes that the same restriction on the admissibility of recordable instruments does not exist in common law jurisdictions, where parties can create property rights with a much larger degree of autonomy (e.g., by means of the creation of a trust instrument).

modifies a property situation in disregard of the taxonomy of real rights recognized by the legal system is only a source of contractual obligations.[35] But Gambaro (1995, p. 67) illustrates the paradox of allowing parties to enter into binding contractual obligations, yet preventing them from enjoying the benefits of those agreements. If the public record system does not allow atypical property rights to be recorded, freedom of contract is itself undermined, because the system withholds the mechanism, namely the recording system, that could transform an atypical property agreement between the parties from a personal obligation into a real right enforceable against third party purchasers.

2.2 Principles of Physical Unity in Property.

Other basic principles of modern property law demonstrate the general tendency of legal systems to combat entropy and promote unity in property. In dealing with the physical partition of property, the rules of civil law systems symbolize the ideal of physical integrity of property. For instance, a large number of civil law systems jurisprudentially or legislatively recognize the owner's right to fence property as a symbolic prerogative of his sovereignty.[36] Furthermore, civil law systems address the problem of physical unity with rules restricting horizontal partitions of property building on the heritage of Roman legal systems that generally limited recognition of subsoil real rights, as suggested by the Latin maxim: "*Cuius est solum eius est usque ad coelum et usque ad*

[35] Rudden (1987, p. 243) notes that the Argentina is the only country that articulated this important logical corollary in the form of a code provision: Argentine CC 2536.

[36] Paragraph 903 of the German BGB, granting the power of absolute disposition, similarly recognized by other codes and civilian courts. See also Mattei (2000, p. 123).

inferos" ("Whoever owns the land owns the property all the way to heaven and all the way to the center of the earth").[37]

The theory and practice of property law regarding physical unity has undergone several changes over the centuries. Whenever recognized, the *ad coelum* rule presumes that someone who buys property unaware of any obstacle to its free use (*bona fide* purchaser) acquires priority over other claims on the land, be they for underground or surface resources.

In spite of the medieval departures from unified conceptions of property, most of the modern Civil codes of the 19th century reinstated the Romanistic conception of property disallowing horizontal forms of property fragmentation. In both the French Code of 1804 and the Italian Code of 1865 land could not be horizontally severed into multiple surface and subsurface estates and legal title to the various land strata had to vest in a single owner. Early common law erected similar obstacles to the horizontal fragmentation of property[38] and, thanks to the work of Lord

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[37] The "*ad coelum*" rule was first found in Gaius's Institutiones, and later reproduced in Justinian's Digest and Institutiones. The basic concept is that real property extends vertically all the way to hell (*inferos*) and heaven (*coelum*). Already in the Republican era of Roman law, however, the so called grants *ad aedificandum* (which were later given full remedial protection through the *actio de superficie*) allowed the creation of horizontal surface rights that could be held by subjects other than the owner of the subsurface estate.

[38] Wenzel (1993) points out that the horizontal fragmentation of property was not permitted at early common law. She attributes this to two main reasons: (a) the popularity of the *ad coelum* rule in medieval English thinking and the dominance of absolutist theories of property; and (b) the practices of land transfer that, through the ritual of "seisin" (resembling the *traditio simbolica* of the Roman law) required the symbolic conveyance of possession via the manual delivery of a stone or clump of soil taken from the land. The ritual of the *traditio simbolica*, Wenzel suggests, was not suitable to symbolize the transfer of title to subsurface rights or undiscovered mineral rights.

Coke in the early 17th century,[39] the abbreviation "*ad coelum*" became a term of art in English law.

These constraints on the freedom of the parties were an important corollary of the principle of physical unity in property that led to the 18th century intellectual reaction against feudal property fragmentation, but they did not shape the ultimate approach to property that emerged in Continental Europe. In spite of the *numerus clausus* principle and the other formulations of the ideal of unitary property, the explicit prohibitions of the modern codes proved ineffective.[40] Property owners continued to partition their land into multiple surface and subsurface estates. Originally such agreements could not convey real title to the various land strata, but parties occasionally attempted to bypass this impediment by agreeing not to invoke accession rules against the titular owner of surface rights, should the informal surface owner decide to erect a building on the land.[41] The courts were initially reluctant to enforce the parties' agreements, which they found in open contravention of the unity rule. Over time, however, civil courts developed a more accommodating attitude and allowed such atypical forms of property fragmentation to survive in the shadow of the law.

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[39] The "*ad coelum*" doctrine is still used in modern law in two main settings, one being in property law, to approach questions of adjoining ownership (e.g., cases of constructions hanging over the neighboring land, etc.); and in international law, to approach issues of territorial sovereignty over airspace. Most recently, the doctrine has been revived in public international law through the claims of equatorial states for their rights over the geostationary orbit (for satellites). Obviously, non-equatorial states oppose the applicability of the "*ad coelum*" rule and invoke the application of a rule of first possession.

[40] As to the vertical limits of property, even in the early times, the appeal to the *ad coelum* rule was mostly symbolic and subject to several exceptions. The value of such symbolism, however, should not to be underestimated, given the interpretive force that is often associated with general principles in civil law systems.

[41] According to the accession rule, *superficies solo cedit*, absent such agreement, the owner of title could claim ownership to any construction erected on the land by third parties.

The 20th century codes eventually abandoned the rule prohibiting the horizontal fragmentation of property. Starting with the German BGB of 1900[42] and the Italian Civil Code of 1942,[43] civil law moved away from applying the principle of physical unity, reverting to the standards in effect prior to the modern codifications.

Any one or more of three practical reasons discussed below reversed the trend. First, horizontal fragmentation was so commonly tolerated, that it no longer was exceptional, and unity became a symbolic legal fiction. Enforcing a rule of unity under such circumstances risked disrupting a peaceful status quo in order to confront the unavoidable dilemma of deciding which of the two good faith parties should acquire title to the property.[44] Second, the risks of horizontal forms of property fragmentation are limited: few parties engage in such partitions, and in practice no more than two layers–surface and subsoil–are likely. This limited form of fragmentation does not raise serious strategic problems, given the bilateral monopoly of the two fragmented owners under the circumstances. Third, the practical need for regulating mineral rights and rights in the exploitation of underground resources prompted the gradual abandonment of the older dogma.

Mid-20th century civil law scholars criticized abandoning the rule of physical unity because doing so violated the modern ideal of unified

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[42] BGB, Paragraphs 1012-17, which were later replaced by a special law of January 15, 1919, which provided a more explicit regulation of the matter.

[43] Article 952 of the Italian Civil Code of 1942 recognizes surface rights as an enforceable real right.

[44] Conflicting claims of building and land owners would have been resolved according to the civilian rules of accession, according to which the owner of the land would acquire title to the building erected by third parties (i.e., *superficies solo cedit*) with a duty to compensate the latter for the lesser amount between the incremental value of the property and the cost of the building. The default solution under the code may have occasionally proven unfair, given the greater subjective value of a building for those who designed and built it, compared to the average market value or the subjective valuation of the unwilling owner of the land.

property. Horizontal property fragmentation appeared antithetical to traditional notions of property ownership that created in a landowner absolute, indivisible rights to a vertical space extending *usque ad coelum, usque ad inferos*, as well as creating mutual constraints on surface and subsurface ownership.[45]

2.3 Principles of Legal Unity in Property.

A third principle of Western law, granting the owner absolute power to dispose of his property, is also closely related to the concept of unity in property, although with quite different implications. All the main European codes enunciate this principle. For instance, Article 544 of the French Civil Code states "Ownership is the right to enjoy and dispose of things in the most absolute manner, " a provision included almost verbatim in the Italian Civil Code of 1865. Similarly, Paragraph 903 of the German BGB affirms that the owner of an object "may deal with the thing as he pleases and exclude others from any interference."

While these statements appear uncontroversial on their face, they become difficult to implement with joint ownership. The principle of absolute disposition indeed becomes an oxymoron when two or more individuals jointly hold decision rights. In addressing this problem, legal systems have historically adopted rules that (a) facilitate the reunification of use and (b) place exclusion rights in the hands of a single individual. The common law achieved these two objectives by making it difficult to create joint tenancy (a legal fiction in which two or more people are regarded as a single owner) and relatively easy to destroy the arrangement. In order to create a joint tenancy, the owners had to be able to demonstrate the four "unities," namely : (a) time (they acquired the

[45] Horizontal partition may prevent valuable improvements, such as leveling the ground for agricultural or construction purposes, excavating for proper drainage, or more simply to create a well or a wine cellar, etc. For a historical survey of the evolving conceptions of physical unity in property, see also Bianca (1999).

property at the same time); (b) title (they all signed the same instrument); (c) interest (they owned identical rights); and (d) possession. If any of these elements was missing, then the joint tenancy could not be created.

Along similar lines, anyone who found himself owning something jointly with others could cause the common property be divided, in keeping with the Latin maxim "*nemo invitus ad communionem compellitur*" (no one can be forced to have common property with another). This could be done unilaterally. All one joint tenant had to do was convey his interest to a third party, and the joint tenancy was severed, reverting to a tenancy in common, that allowed the owners to convey or devise their interests to third parties. Some early cases found that merely expressing the intent to sever the joint tenancy was sufficient to do so. If the tenants could not agree on the management of the property, another option was to petition for partition, in which case the court would either divide up the property or order it sold and divide the proceeds among the owners. Very similar rules are present in civil law jurisdictions to minimize the hold-up power of joint owners in the use of the joint property. In application of the principle of legal unity in property, these systems introduced mechanisms that were easily triggered to allow owners greater autonomy in disposing of their property, even when others had rights over the same land.

2.4 Towards the Recognition of New Forms of Property

As discussed above, in the modern era legal systems around the world have in different ways manifested a general reluctance to recognize atypical property agreements as enforceable real rights.[46] In recent

[46] Recently, common law courts have been relatively creative in figuring out ways to enforce contracts that create covenants designed to protect existing amenities in residential areas. Furthermore, legal systems occasionally will invent a new form of property. Despite these periodical innovations, this area of the law remains the most archaic. Rose (1999, pp. 213-214) observes that the common law system of estates in

decades, however, courts and legislatures in both civil and common law jurisdictions, attuned to the modern needs of land developers and property owners, have recognized new property arrangements.[47] The clearest example of this gradual expansion of standard property arrangements in civil law jurisdictions, can be found in the area of covenants that run with the land and that occasionally create new *sui generis* real rights. A real covenant is a promise to do, or refrain from doing, something that is connected to land in a legally significant way.[48] Under traditional common law, the rights and duties associated with contracts were not assignable (Corbin, 1926) because parties to the original agreement did not have the right to bind third parties to adhere to their arrangement. Accordingly, the benefits and burdens of the original covenants did not transfer with the interest in the land. In many

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land now seem almost risibly crude and antiquated. As the author ironically points out, references to the "fee tail" seldom fail to bring a smile.

[47] Yiannopoulos (1983) notes the inadequacy of building and zoning ordinances to satisfy the needs of local property owners (e.g., for the preservation of the subdivision style, etc.). He also mentions that land developers have, since the turn of the century, imposed contractual restrictions limiting the use of property to enhance property values (e.g. restricting use to certain specified purposes, prohibiting the erection of certain types of buildings, or specifying the material or the colors that may be used in the construction). Rudden (1987) observes, along similar lines, that although standard possessory interests involve exclusive and continuous possession, individuals may seek to acquire alternate interests such as a time-share, which is exclusive possession for repeated, short intervals. He thinks that servitude interests have seen the most innovation of late, and that security interests have seen the least innovation.

[48] Real covenants and easements differ from one another in various respects. An affirmative real covenant is a promise to do an affirmative act (e.g., a landowner's agreement with her homeowner's association to pay yearly fees, or a landowner's agreement to keep his lawn well trimmed). An affirmative easement, by contrast, is a right held by the owner of the benefitting land, called dominant estate, to use another party's land, called servient estate. There is no affirmative obligation for the servient estate owner to do anything. As it is generally explained, the servient owner only has a "negative duty" to refrain from interfering with the other party's rights.

situations, this frustrated the purpose of creating a real covenant in the first place.

Due to the perceived net benefits in having the rights and burdens of a real covenant attach to the title to property (i.e., "run" with the land), courts gradually created a new body of law to overcome the obstacles posed by traditional property and contract theories.[49] Almost without exception, however, legal systems implementing these innovations have created atypical regimes to govern remedial protection and regulate these new rights, rules that diverge substantially from the traditional principles governing property or contracts. Commentators generally attribute these divergences to mere historical accidents (Dwyer and Menell, 1998, p. 760; Yiannopoulos, 1983). Contrary to the common wisdom in the literature, I suggest that these anomalies are not haphazard.

In order to protect these newly recognized real rights, courts have developed an elaborate set of requirements to minimize the long-term effects of the non-conforming fragmentation of property, adopting a set of rules that differ from traditional property or contract law. Legal systems instead balance the need to mitigate entropy in property by creating perpetual restrictions on the use and alienability of property with the demands of landowners and property developers, wishing to exercise their contractual freedom to dispose of their property as they deem appropriate. Various legal traditions have employed different instruments to achieve this goal. For example, under modern French law, courts do not recognize atypical property covenants as sources of real rights, though they allow parties to approximate a real right by drawing on the notion of transferable obligations. Thus, French cases have construed

[49] Under the modern contract doctrine, an assignee is liable for pre-existing contractual obligations only if he or she expressly assumes those obligations. The problem of the law of real covenants is thus principally concerned with situations where the assignee has not expressly agreed to assume the covenants of the previous owner. Enforcing these real covenants as mere contracts would often frustrate the goals pursued by the parties, given the frequent objective to allow the burdens and benefits of real covenants to pass to the successive owners of the underlying estates.

contracts between property owners as sources of obligations that are effective against third persons.[50] In Germany and Greece, atypical property covenants are also not enforced as real rights, but, as Yiannopoulos (1983) points out, allowing the contractual remedies to extend beyond the original parties to the covenant produces similar effects.

2.5 Freedom of Contract and the Potential Value of New Forms of Property

Although much of the discussion in this paper considers the legal responses to problems of entropy, it is important to note that legal systems create or encourage non-conforming forms of property only in limited situations.

Interestingly, legal systems often encourage open access to common property (e.g., roads, navigation, communications, ideas after the expiration of intellectual property rights, etc.),[51] and in other cases the legal system creates and facilitates fragmentation. For instance, the social planner uses entropy to his benefit by using conservation easements and the fragmentation (e.g. multiplication) of administrative agencies

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[50] Yiannopoulos (1983) observes that the French Supreme Court (*e.g.*, Civ., Dec. 12, 1899, D. 1900.1.361, with a note by Gény) recognized the effect against third parties of a property covenant relieving the operator of a mine from liability for damage to the surface. See also Bergel (1973).

[51] See Rose's seminal 'Comedy of the Commons' (1986), describing the origins of, and justifications for, common law doctrines and statutory strategies that vest collective property rights in the "unorganized" public as a means of optimal resource management. Most recently, Smith (2000) introduced the notion of semi-commons. These are property arrangements consisting of a mix of both common and private rights, with significant interactions between the two, observing that this property structure allows the optimizing of the scale of different uses of the property (e.g., larger-scale grazing, smaller-scale grain growing, etc.).

overseeing of land development to slow the pace of suburban development.[52] In yet other instances, the owners themselves structure the non-conforming property arrangements.[53]

Although problematic as a rule, non-conforming partitioning of property rights may be somewhat sensible in achieving specific policy goals or other objectives that property owners desire. These idiosyncratic arrangements are both a reflection of the individual's right to freedom of contract and a legitimate policy instrument for the urban planner. In sum, respecting individual autonomy while minimizing the undesirable deadweight losses that could result from these arrangements is the critical goal.

3. Entropy and the Legal Remedies for Unified Property

Entropy occurs when a scarce resource is divided into non-conforming fragments, thereby foregoing complementarities.[54] Initially it

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[52] The idea of the anticommons in environmental regulation is explored further in Mahoney (2001).

[53] Most recently, Dagan and Heller (2001) present the case of the liberal commons as a compelling illustration of efficient commons. Less obviously, we could imagine cases of purposely chosen anticommons. Examples of purposeful dysfunctional property fragmentation can be found in situations where unified property owners want to generate anticommons problems as a way to control the use of their property beyond the time of their ownership. An interesting real life example is offered by the case of nature associations and mountain-hiking clubs that utilize anticommons-type fragmentation as a way to ensure long-term or perpetual conservation of the land in its current undeveloped state.

[54] In general terms, dysfunctional fragmentation occurs when "closely complementary" attributes of the property are dismembered. Use and exclusion rights are a paradigmatic example of strict complements in the bundle of property. However, besides this paradigmatic case, we can easily think of other essential attributes of a property right that are meant to be in the control of a single individual. Anticommons

might look reasonable at first to divide the property. Later, however, an opportunity might arise to exploit the complementarities that used to exist between different parts of the now fragmented property. The initial seemingly attractive choice turns out to be suboptimal in the end because of the greater costs of reunification.[55] I suggest that legal systems consider these asymmetric frictions. They then attempt to identify the optimal choice of rules and structure of remedies that will minimize the total deadweight losses from entropy in property. In fact, several rules and doctrines in the field of real property can be evaluated in light of this hypothesis.

Modern legal systems avail themselves of different dogmatic constructs, but three main approaches generally are employed to balance the effects of these non-conforming property arrangements: (a) the creation of rules promoting reunification mechanisms for neglected or outmoded property rights; (b) granting selective remedial protection for atypical property rights; and (c) jurisprudential creation of a general principle of *favor libertatis*, namely a strong presumption in favor of unified and unrestricted ownership. These legal instruments will be discussed next.

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problems may emerge when such a dysfunctional separation occurs.

[55] As discussed in Section 1, there is no static notion of optimal fragmentation. History has shown that what may have been an efficient property framework under certain social and economic circumstances may become suboptimal under different conditions and vice-versa. Imagine the fragmentation of a large estate, such as a former farm, into buildable lots, when the surrounding area consists of valuable small-acreage residential property. In such a case, there are fewer forgone synergies between the various fragments, and those lost synergies are sufficiently overcome by the reduction of lot size to an optimal scale for the new residential purpose. Policymakers cannot perfectly control the volatility of land development and the resulting changes in the optimal use of property. However, they may attempt to ensure that property maintains sufficient flexibility to adapt to the changing needs of the time.

3.1 Reunification Mechanisms for Fragmented Property.

In recent years, the proliferation of atypical property arrangements (such as private communities and residential subdivisions) has necessitated reunification mechanisms to deal with anticommons problems. Modern property law includes a sort of "gravitational force" which joins property fragments and terminates obscure, neglected, or outmoded property claims. As pointed out by Rose (1999), legal systems pursue this goal in a variety of ways, disposing of unduly burdensome claims against property and limiting the right to oppose property transactions only to the original parties and to third parties who had sufficient notice of the arrangement. Recording systems are a key factor: unrecorded or unregistered claims, for example, are forfeited against innocent third party buyers. Other contractual limitations on the use of property that are not visible or properly recorded also cannot be enforced against subsequent purchasers.[56]

Similarly, rules of liberative and acquisitive prescription (at civil law) and statutes of limitation (at common law) are also frequently used to extinguish outmoded property claims. In some common law jurisdictions, real covenants automatically expire after a statutorily fixed period of time unless renewed (Dwyer and Menell, 1998). In civil law jurisdictions, full property rights are not subject to liberative prescription,[57] but limited property rights often are. For example, the term for the prescription of *nominate* property rights is usually 20 or 30

[56] Rose (1999) further observes that this creates incentives to publicize and to record their claims and, most importantly, to use standard-form property packages.

[57] Property is obviously subject to acquisitive prescription (i.e., adverse possession).

years.[58] In contrast, one must bring action for injunction or damages if an innominate or atypical property right (such as building restriction or

subdivision covenants) is violated in a much shorter period of time.[59] In all these cases, statutes of limitation do not merely bar the action to enforce the atypical property right, but rather extinguish the real right itself, in essence reunifying the fragmented property with respect to third parties.[60] Upon prescription of the rights, the restrictions are treated as if they never existed, and the property is permanently freed of all the burdens that had been violated.[61]

These rules have been applied quite liberally. For example, according to traditional civil law principles, liberative prescription can only accrue against actual violations to which there has been no response for the entire duration of the statute of limitation. This approach is

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[58] See, for example, Article 617 of the French Civil Code, setting a 30 year prescription term for usufruct. Likewise, Paragraph 195 of the German BGB establishes a general 30 year prescriptive period applicable to real actions. Conversely, Articles 970 and 1014 of the Italian Civil Code establish a 20 year prescription, for emphyteusis and usufruct rights, respectively.

[59] For example, according to Article 781 of the Louisiana Civil Code (as revised in 1977), "no action for injunction or for damages on account of the violation of a building restriction may be brought after the lapse of two years from the commencement of a noticeable violation." See also the official Comment (a) under Article 781, which states that this provision does not change the law, when instead it has been emphatically noted by Yiannopoulos (1983) that such prescriptive terms depart substantially from the general rules governing the prescription of contractual obligations (with a 10, rather than 2 year prescription).

[60] These prescription terms are often surprisingly short. See for example the case of the Louisiana statute of limitations extinguishing the real rights after two years from the commencement of the violation. Note that, in the same jurisdiction, a personal action for the enforcement of restrictions would be subject to a much longer 10-year term of liberative prescription. See La. Civil Code Article 3499, as revised in 1983; (formerly Article 3544 of the 1870 code). Also see Yiannopoulos (1983).

[61] See Yiannopoulos (1983) discussing La. Civil Code Article 781, as revised in 1977.

consistent with the conception of *usucapio libertatis*, namely the reinstatement of complete freedom of use after the extinction of preexisting restrictions on the property. But courts are often much more active, freeing the property from other related limitations.[62] Likewise, courts have construed the prescription of a restriction against a given property parcel as tantamount to abandoning the restriction for the entire community or subdivision,[63] resulting in an exponential increase in the reunification of fragmented property.

From a policy perspective, these doctrines are problematic, since they undermine the force and stability of the original contract to restrict the use of the land. Such doctrines, however, can be explained as attempts to mitigate the effects of asymmetric transaction costs and resulting inefficiencies of fragmented property.[64] In most cases, the

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[62] According to long standing legal principles, the extinction of one type of a restriction due to the lapse of a statute of limitation does not affect the enforceability of other types of restrictions, nor does it extend to other situations (e.g., freeing other lots from the type of restriction that have been violated). Nonetheless, as Yiannopoulos (1983) points out, courts have recently held that when an owner uses his property for commercial purposes contrary to subdivision covenants during a period in excess of two years, the property is freed of all restrictions pertaining to commercial use.

[63] According to Article 782 of the Louisiana Civil Code, building restrictions terminate "by abandonment of the whole plan" or by "a general abandonment of a particular restriction." Abandonment, like prescription, does not merely bar the right of action for the enforcement of restrictions; it extinguishes the real right. See La. Civil Code Article 782, as revised in 1977, extensively discussed in Yiannopoulos (1983).

[64] Along similar lines, a survey of American property law by Michael Heller (1999) reveals what he terms a 'boundary principle' which limits the right to subdivide private property into wasteful fragments. Property law responds to excessive fragmentation with the use of a variety of rules and doctrines such as the rule against perpetuities, zoning and subdivision restrictions, property taxes and registration fees, etc. See Heller (1999, pp. 1173-1174), citing zoning and subdivision restrictions such as minimum lot sizes, floor areas and setbacks that prevent people from spatially fragmenting resources excessively. Heller suggests that, by making the creation and

availability of these ex post reunification mechanisms protects the integrity of the ex ante fragmentation of property: because the dangers of entropy in property and anticommons welfare losses are eliminated, the value of the initial decision to fragment the property is maintained.

3.2 Entropy and the Selective Use of Remedies

Selective remedies also minimize the effect of entropy and anticommons losses. Quite interestingly, even legal systems that have recognized new forms of atypical property provide them less remedial protection. In contrast to other real rights (e.g., affirmative or negative easements) at common law, atypical real rights (such as real covenants) are enforceable only with damages.[65] Indeed, although it is now recognized that covenants transfer with land, an individual still cannot obtain an injunction to enforce his rights even upon proof of a valid covenant. The right holder can obtain a judicial declaration of his rights, but the defendant can persist in the violation simply by paying damages.

The limited protection given to atypical (or innominate) rights still characterizes the modern-day law of remedies in both common law and civil law jurisdictions. Professors of Property law often cite this fact as one of the many unexplained puzzles of their field,[66] assuming that availability of liability-type remedies for certain categories of real rights is merely coincidental. In a popular textbook on property, Dwyer and Menell (1998, p. 760) observe that "because of one of the many historical

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maintenance of fragments more costly, such as through annual disclosure expenses, excessive fragmentation into low-value fragments will be deterred and existing fragments will be abandoned so that the state can afterwards rebundle them.

[65] In case of a breach of a real covenant, for example, the dominant landowner can only obtain relief through damages.

[66] See also Stoebuck (1977).

accidents that plague property law, real covenants are enforced by a damages remedy only." I suggest that these anomalies are not merely happenstance.

As discussed above, the asymmetrical effects of entropy in property dictate that remedies should be determined based on the expected directional costs, as opposed to the average or total transaction costs in the contract or property relationship. This justifies a system that favors more liberal use of property-type remedies when redressing claims of owners of non-fragmented property and that requires limited liability-type protection in response to claims concerning dysfunctional property. This selective use of remedies is analogous to a gravitational force that can overcome entropy in property. These legal mechanisms promote the reunification of rights and privileges that should naturally be held by a single owner, given their complementarity. This reunification regenerates the natural conformity between the complementary attributes of a right (e.g., between use and exclusion rights), even though, because of the natural laws of entropy, the restoration of the *status quo ante* requires additional expenditures.[67]

Interestingly, most of these default reunification mechanisms do not apply with respect to typical property rights,[68] which, in fact, already are internal consistent, thereby eliminating the need to favor reunification over preserving the *status quo*. Conversely, non conforming property arrangements (i.e., those that dismember the closely complementary attributes of a property right) are either (a) subject to time limitations, or (b) enjoy the effect of automatic reunification mechanisms discussed in

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[67] Restoring the original natural arrangement requires legal and transactional efforts (just like rolling the stone back up the hill requires physical efforts with an increased expenditure of energy). In short, after the reunification things may look like they did before, but the journey is not without social costs.

[68] Merrill and Smith (2000) pose the interesting question as to why such preoccupations arise only with respect to atypical real rights. The authors' conclusion dismisses Heller's (1999) anticommons explanation of the *numerus clausus* doctrine and suggests that the goal of such rules is the minimization of information costs.

the previous section. In addition, application of selective remedies can minimize the welfare loss occasioned by entropy.

Only substantial and systematic asymmetries in transaction costs, could justify the use of directional remedies.[69] Examples of such asymmetries include those produced by (a) structural attributes of the relationship; (b) an uneven number of parties; or (c) asymmetric strategic incentives among the contracting parties. Whenever such systematic differences are expected, remedies might be chosen in order to minimize the expected social deadweight loss that could vary within the same relationship in response to a wide range of concerns.

3.3 Favor Libertatis and the Natural Conception of Property

The recognition of new forms of property rights further necessitated the articulation of general principles to minimize the risk of entropy in property. These principles are derived from the concepts of absolute property, advocated by 18th century jurists, and most are simple applications of the ideals of unity in property.

The resulting conception of property as an absolute right suggests that owners enjoy property through a direct relationship with the thing they own, without any need for cooperation by third parties. This characterization of an absolute right distinguishes it from the nature of a relative right (such as personal obligations and credit rights) the

[69] The implementation of a paradigm of "directional remedies" obviously requires *ex ante* information concerning the magnitude of directional costs. The choice of remedies undertaken in the previous section, in fact, refers to *ex ante* choices of optimal remedies. Remedies are selected on the basis of the expected directional costs, and would not be applicable in situations where no systematic directional differences can be expected. An *ex post* evaluation of such costs, while potentially improving upon the allocational efficiency, would increase the uncertainty of the available remedial protection for the current owners, reducing the incentives for value-enhancing investments for rational, risk-averse owners.

fulfillment of which depends on the active cooperation of another party. This classification of rights has given succeeding generations powerful rhetoric in which absolute rights (such as property and right of the person) only create negative obligations enforceable *erga omnes*, effectively equating property with (negative) freedom.[70] During the 20th century, the equation between the structure of absolute rights and freedom became commonplace in legal, economic, and political theory.

Civil law courts have also subscribed to this general principle, developing an interpretive presumption in favor of a unified property that is often referred to as the *favor libertatis* principle. It suggests that restrictive burdens on property must be interpreted to promote, to the extent possible, the freedom of the burdened property.[71] This presumption is clearly related to the post- French Revolution ideals of unity in property. From a purely interpretive perspective, however, it departs from the general principles governing the interpretation of contracts, which mandate that the contracts should be interpreted to ensure that they can produce some effects, even if such effects limit the property's freedom.

Absent a general presumption of *favor libertatis*, common law courts have taken another approach to unity, enshrined in the doctrine of "changed circumstances." This allows courts to eliminate restrictions that have lost their original purpose and value, without having to obtain the unanimous consent of the various right holders (Rose, 1999). A subdivision restriction, for example, might require the use of outmoded architectural details or the use of outdated and inefficient building materials. A contractual abrogation of such subdivision covenant may

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[70] Mattei (2000, p. 123) observes that the "taxonomy requiring the object of ownership to be a tangible material thing can be explained as an expulsion from the domain of property law of those powers not related to a physical relationship with land, as used to be the case with most feudal property rights."

[71] As an application of this principle, documents that establish restrictive covenants must be interpreted in favor of, rather than against the freedom of the servient estate Yiannopoulos (1983).

prove difficult because of the likely holdout problems of the various property-holder's rights.

Traditionally, common law jurisdictions enforced real covenants at law even though changes in the surrounding environment (e.g., gradual transformation of a residential subdivision into a commercial or industrial area) undermined the original purpose and value of the parties' covenant. In recent years, however, the majority of states have adopted a different rule to deal with obsolete real covenants, holding that the doctrine of changed circumstances is a defense to a claim for damages and may be used to terminate a real covenant.[72]

If a sufficient number of covenant restrictions have been violated, courts tend to consider the general subdivision plan as abandoned.[73] At that point, all other covenant restrictions are extinguished and the use of the property is freed for all general purposes (Yiannopoulos, 1983).[74]

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[72] *Hess v. Country Club Park*, 213 Cal. 613, 2 P.2d 782 (1931); *Restatement of Property* § 564. For a more extensive discussion, see Dwyer and Menell (1998) and Stoebuck (1977).

[73] In the Louisiana jurisprudence, the abandonment of a particular restriction is construed as an abandonment of a real covenant, affecting all parties to the original covenant. Changes in the vicinity of the subdivision, but not within it, are thus without effect on the validity of the building restrictions in the subdivision (Yiannopoulos, 1983).

[74] Article 783 of the Louisiana Civil Code declares that doubt "as to the existence, validity, or extent of building restrictions is resolved in favor of the unrestricted use of the immovable." According to Louisiana courts, since servitudes and covenant restrictions often have effects similar to those of other building restrictions, any covenant that establishes restrictions on property use ought to be interpreted in *favorem libertatis.* Yiannopoulos (1983). Thus, when there is doubt as to the content or validity of a restriction (e.g., a question on the validity of a subdivision plan or real covenant), the doubt is resolved favoring the unrestricted use of property. Yiannopoulos also provides several cases and examples explaining that when a particular subdivision restriction has been abandoned, the properties in the same subdivision are freed from that restriction only. Thus, a change in the neighborhood from residential to commercial does not automatically affect other functionally

4. Freedom of Contract and the Laws of Entropy

There is a peculiar tension between the principles governing property and those related to contracts.[75] Traditional contract theory grants full autonomy to the parties and allows them to customize their contractual relationships as they see fit.[76] Yet property law limits contractual freedom by allowing only a closed list of standardized property forms and restricting the parties' autonomy in attempting to customize the content of property rights.[77]

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unrelated restrictions (e.g., setback from property lines) but may affect other functionally related limitations.

[75] This apparent anomaly in the coordination of property and contract rules has been overlooked in the literature. Recent research suggests that Anglo-American courts intuitively responded to the dangers of unrestricted fragmentation by obstructing the running of personal promises attached to land in favor of objective arrangements intrinsic to the land in question. See Depoorter and Parisi (2000).

[76] The legal concept of freedom of contract emerged in the late 18th-early 19th centuries as an offspring of the ideal of economic and intellectual freedom espoused by liberal political theory (Gordley, 1991). Continental European contract theory applied the notion of freedom of contract to a wide range of situations that are generally grouped under the three general headings of freedom of form, type, and object. By the end of the 19th century, English law had also consolidated a principle of freedom of contract which stood as a central tenet of its framework of private ordering. The 19th century ideal of freedom of contract rejected the imposition of legal constraints to the free determination of the parties to a contract but left room nevertheless for a distinction between typical and atypical property arrangements with a differentiated remedial protection. (Parisi, 1995).

[77] As mentioned above, these contractual freedoms are often grouped under three general headings in European contract theory, namely freedom of form, type, and object (Parisi, 1995). The freedom of type addresses issues of taxonomy in contractual arrangements. The thrust of this freedom is that parties to a contract are at liberty to forge new types of contracts outside of the standardized contractual types of the

While the *numerus clausus* doctrines (or the "off-the-rack" classification of property entitlements, as Rose (1999) calls it) fulfill a role comparable to that of standard-form contracts (e.g., reducing transaction and information costs among present and future property owners) such doctrines do more than just provide standardized solutions.

In regulating typical forms of property, legal systems generally specify the formative elements of the available real rights and enunciate mandatory rules that govern the prerogatives of the various right holders. Unlike standard form contracts, *numerus clausus* doctrines curtail the freedom of the parties to innovate and to go beyond available prototypes to tailor special arrangements appropriate to the circumstances. In short, property owners cannot opt out of these standard-form alternatives. Even though the parties can contractually agree to be bound by different rules in their relationship with one another, legal systems do not recognize such contractual amendments as enforceable real rights.[78]

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modern Civil law codes. In the history of contract law, *innominate* or atypical contracts are, indeed, defined as those contracts that do not fall within standard contractual types, and for which the law does not provide any specific set of rules designed for the particular transaction. These atypical contracts enjoy full enforcement by the legal system and are generally adjudicated on the basis of the general principles of contract law (often contained in the titles "On Contracts in General" of the European codes) and the specific choice of governing provisions agreed upon by the parties.

[78] Rose (1999) notes that, while private parties may contract around many features of the typical forms of property, legal systems normally impose stringent requirements for the recognition and enforcement of these rights against third parties (French 1982; Ayres and Gertner 1989). These restrictions often go beyond the obvious need to provide notice to third parties and subsequent purchasers.

4.1 In Search of a Rationale

The doctrines of unified property are usually accepted as self-evident dogmas of the civil law, and as such they have enjoyed only limited attempts at rationalization. One occasionally voiced argument is that the *permitted* property interests encompass *all possible* property interests.[79] This explanation, which has been referred to as the "absence of demand" rationale, obviously proves too much. If we had no demand for the creation of atypical property rights, the *numerus clausus* doctrine would have no reason to exist, or else its abstract application would be uncontroversial. In real life, however, individuals do attempt to create alternative property interests, rendering such doctrines relevant and often controversial.

It is often suggested that the limits to commodification of property lie in the fact that property arrangements are opposable *erga omnes*, thus affecting third parties that were not in privity with the original contract.[80] Most recently, Mattei (2000, p. 39) invokes this explanation to justify the dichotomy between contract and property doctrines, noting that, unlike personal contracts, property arrangements

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[79] This argument is considered by Rudden (1987) in the context of the *numerus clausus* of property interests.

[80] The idea is that when property rights are created, everybody is bound to respect such rights, even if they are not in privity with the original parties. Conversely, when a mere contractual right is created, such agreement binds only the individuals who actually entered into the contract. (Mattei, 2000). Applying Wesley N. Hohfeld's (1923) conception of rights, Rudden (1987, p. 251-2) thinks that a fancy property right could "alter *for the worse* the legal position of people who did not consent thereto." Rudden illustrates his point with the following observation. Suppose Black owns Blackacre, and, next door, White owns Whiteacre. If White gives Black a right of way over Whiteacre, then that transaction imparts to Black a replica of White's claim that no one build on Whiteacre. Thus, in a transaction involving only Black and White, the legal position of the rest of the world is altered in that they now owe "Black a duty-not to build."

can have essentially perpetual ramifications.[81] The need to limit the "permanent impact" of property rights over scarce resources justifies in Mattei's view, various property doctrines, including the common law rule against perpetuities and other rules that promote unity in property. These rules try to limit the impact of property fragmentation on future generations so that, even without a full-fledged *numerus clausus* doctrine, common law systems recognize the need to limit entropy in property.

Various economic rationales for the property versus contract dichotomy have also been examined and readily dismissed by legal scholars. The marketability justification of restrictions on the fragmentation of property is related to the idea that the creation of atypical property rights would have the potential to hamper marketability of land.[82] But, as pointed out by Rudden (1987), the only real effect of dysfunctional fragmentation of property would be to affect the price of property. Furthermore, I would add that rational owners are induced to discount the loss of value or marketability of land when deciding whether to fragment and market forces would thus serve as a natural limit to inefficient forms of property fragmentation.

Many commentators are concerned that the proliferation of atypical encumbrances on property would sterilize the efficient development of land. Rudden points out several objections to this apprehension: some positive obligations (e.g. Roman support obligations) can augment the value of two lots; obligations can be canceled; sellers can obligations by other, more expensive methods. Moreover, positive obligations such as central heating could actually increase the efficiency of land. Such obligations are typically allowed only if there create a "corresponding advantage." But different legal systems have varying

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[81] Mattei (2000) calls this effect the "permanent impact factor."

[82] Rudden (1987, p. 254) cites a quotation from Ginossar (1960): "every real obligation risks creating an obstacle to the free circulation of things." Thus, fancies may be prohibited to reduce the difficulty and costs of transactions in general.

view as to what constitutes a "corresponding advantage." As a general rule, property interests are created so that they will endure for a long period of time. But atypical real rights respond to evolving and dynamic needs which do not justify their enforcement as perpetual real rights.

4.2 Property versus Contract: Information Cost Explanations

Legal scholars have recently used transaction and information cost arguments to explain the emergence of unified property doctrines. Most notably, Rose (1999) suggests that limitations on the freedom of the parties to create atypical property rights are linked to the governmental function of record-keeping. Governments provide off-the-rack property entitlements because property arrangements are likely to produce effects that extend beyond the life of the contracting parties and thus need to be easily tractable.

This distinctive feature distinguishes property from all other aspects of patrimonial private law. The *erga omnes* effects of property arrangements create a need for effective notice to third parties. As Mattei notes, such public notice could not be effectively provided if the parties were left free to forge new forms of property. Rudden (1987) points out that from the point of view of buyer, the consequence of *numerus clausus* is that he has to search only for a limited set of entitlements, and that he will consequently owe fewer obligations to individuals other than the seller.

These arguments reveals both the foundation and limits of the information cost explanation. If we could organize a public record sufficiently dependable to keep track of property rights, there would be no reason to limit their number. Mattei (2000, pp. 91-92) pushes this argument to its logical conclusion, observing that the property owners' freedom to dispose of their property and to fashion new legal property regimes "should be safeguarded until the social signals that he or she

conveys to the market are not ambiguous and capable of misleading the reliance of third parties."

Merrill and Smith (2000) have offered the most recent variation on the information cost rationale, suggesting that, because of the long-term (or perpetual) nature of most property arrangements, it is necessary

> to package property transactions in such a way that subsequent purchasers can easily recognize and respect their nature and content.[83]

According to all the scholars above, the rules that limit parties' autonomy in favor of unified property are necessary to alleviate informational problems in the transfer of property. More specifically, the *numerus clausus* doctrine is regarded as a sensible restriction that allows future owners (or at least their lawyers) to understand the content of an encumbrance or restriction on the use of their property.

These arguments, while persuasive to their adherents, fail to consider that information cost arguments cannot easily explain a large number of doctrines related to unitary property. Vertical and horizontal forms of fragmentation, for example, pose similar informational problems. Yet, legal systems are less liberal in permitting one form of fragmentation than the other. By the same token, most real covenants are as easily recordable and tractable as other real servitudes, yet legal systems treat such rights quite differently in terms of recognition and remedial protection.

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[83] Merrill and Smith (2000, p. 8) set forth a positive theory of the *numerus clausus*, providing an explanation for why property rights, unlike contract rights, are restricted to a limited number of standardized forms, stating "The root of the difference ... stems from the in rem nature of property rights: When property rights are created, third parties must expend time and resources to determine the attributes of these rights, both to avoid violating them and to acquire them from present holders. The existence of unusual property rights increases the cost of processing information about all property rights. Those creating or transferring idiosyncratic property rights cannot always be expected to take these increases in measurement costs fully into account, making them a true externality. Standardization of property rights reduces these measurement costs."

Most generally, information cost explanations lose most of their cogency as new information technologies increase the possibility of real-time and inexpensive access to public records. Nevertheless, the strong presumption against judicial recognition of new forms of property retains its power across legal systems. In the following pages, I shall formulate a different economic justification for the various doctrines of unity in property considered above.

4.3 Entropy and the Economic Rationale for Unified Property

In a world of zero transaction costs, an efficient allocation of resources occurs regardless of the initial allocation of legal entitlement and choice of remedies to protect them.[84] If all rights are freely transferable and transaction costs are zero, an inefficient initial partitioning of property rights would not prevent a final efficient use of the resources. In the event of inefficient property fragmentation, voluntary agreements would reaggregate property into appropriately-sized clusters, maximizing the property's total value.

In the real world, however, the reunification of fragmented rights usually involves transaction and strategic costs of a greater magnitude than those incurred in the original act of fragmentation. The reasoning leading to this result is quite straightforward. A single owner faces no strategic costs when deciding how to partition his property. Conversely, multiple non-conforming co-owners are faced with a strategic problem, given the interdependence of their decisions. The strategic choices of owners impede the optimal reunification of non-conforming fragments into a unified bundle.

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[84] Coase (1960). See also Eggertson (1990b, pp. 38-39) on attenuation and partitioning of property rights.

In the context of property, Posner (1998, p. 76) first recognized the costs of excessive property fragmentation.[85] Heller (1998) most recently made the argument that it is often harder to regenerate separated bundles than to fragment them; Buchanan-Yoon (2000) and Parisi-Schulz-Depoorter (2000) restated this thesis with formal economic models.

The interesting point here is that, while property fragmentation may occasionally be ex ante efficient, given the specific goals pursued by property owners, it may result in inefficient ex post allocations. Furthermore, in spite of the perfect alignment of the individual owners' private and social incentives, problems of entropy persist. Owners aim at maximizing the value of their property, but, given some uncertainty on the optimal final use, they do so with some normally distributed margin of error. Because of the one-directional stickiness in the fragmentation process (i.e., sub-optimal fragmentation can be easily corrected ex post, while excessive fragmentation is likely to be irreversible) the normal distribution of errors has cumulative, rather than offsetting, effects on

[85] Posner first recognized the costs of excessive fragmentation, providing an application in the property law of servitudes. The common law distinction between promises that touch and concern the land and restrictive covenants that are merely personal is explained in this light. The idea, formulated in the early editions of his textbook, is expressed in the latest edition as follows: "One reason is that having too many sticks in the bundle of rights that is property increases the costs of transferring property." (1998, p. 76). Some of the usual transactional impediments can be expected: (a) finding and negotiating among the parties, and (b) overcoming strategic bargaining. Notably, the former is more likely to dominate commons problems, whereas the latter tends to dominate anticommons situations. Search and transaction costs would be generally high in traditional commons (open access) cases, given the potentially unlimited number of individuals that could enter an open access resource, destabilizing and exploiting any agreement that the incumbent users could have reached among themselves. In anticommons cases, however, as in Heller's storefront properties, each party tries to exercise a right to exclude. But to make that threat work, the party has to identify him/herself to the other parties. Hence, the problem will not be finding the rights-holders, but rather getting them off their respective strategic bargaining positions.

society.[86] In short, the effects of a ill-conceived allocation of property rights do not fade away over time.

4.4 Rational Owners and Inefficient Fragmentation: Revisiting the Puzzle

The ideal choice of remedy for entropy should consider the effects of a dysfunctional fragmentation of property, balancing a wide range of concerns. As for the general case, policymakers should keep in mind that the choice of alternative remedies has both prospective and retrospective effects.

Prospectively, alternative remedies would lead rational owners to make different decisions under property rules than they would under a liability regime. In contrast to Epstein (1982), I suggest that, absent an appropriate choice of remedies, the property owners' rationality will not be sufficient to minimize the cost of entropy in property. Rational parties, it is conceded, will anticipate any devaluation from fragmentation and will also take into account the expected present value of forgone opportunities when fragmenting the entitlement. But the rational choice for a level of fragmentation will differ under different remedies. In a liability-type regime, owners will choose a level of fragmentation for their property, keeping in mind that the liability remedy will lower expected

[86] An illustration might be helpful. Consider the case of an owner who purposely chooses to fragment his property as a way to control the property's future use (e.g. the case of environmental clubs and wildlife associations that utilize anticommons-type fragmentation as a way to ensure long-term or perpetual conservation of the land in pristine state). The size and configuration of each fragmented parcel is intentionally chosen to render any parcel (or combination of few parcels) unusable for other practical purposes. If the preservation goal which motivated the anticommons fragmentation becomes impossible due to some unforeseen act of nature (e.g., the wildlife abandons the reserve, or a fire destroys the natural flora and fauna that warranted preservation, etc.), both the fragmented owners and society are left with a sunk cost, given the wasteful patchwork of unusable small entitlements.

reallocation costs. Conversely, under a property-type rule, owners will choose a lower level of fragmentation because of the higher costs of rebundling property at a later stage. In sum, the choice of different remedies affects the social loss occasioned by the rational choices of property owners simply because rational owners would make different choices under various remedies.

Retrospectively, the choice of different remedies has an important effect on the control of entropy in property. In the realm of non-conforming property arrangements, entropy generates a one-directional stickiness in the transfer of legal entitlements.[87] As discussed above, externalities and holdouts are two major impediments to rebundling fragmented property. The optimal legal remedy will be the one that minimizes the net social cost of externalities and holdout costs in any particular institutional setting. In the property context, one-directional transaction and strategic costs would justify a more selective use of liability-type remedies.[88] The comparative study of real remedies bears out the hypothesis that legal systems will grant less extensive property-type protection to non-conforming property arrangements. Likewise, other legal rules may create default reunification mechanisms. Time limits, statutes of limitation, liberative prescription, rules of extinction for non-use, etc., can all be regarded as legal devices to facilitate the otherwise costly and difficult reunification of non-conforming fragments of a property right.

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[87] If atypical rights were classified and enforced as property, with property remedies (rather than mere contracts, with liability type remedies), there would be prohibitive transaction costs in their *termination*, rather than their *creation*. See also Reichman (1982, p. 1233).

[88] In the field of contracts, a more liberal use of specific performance may be expected with respect to contracts that are aimed at reunifying non-conforming fragments of property, rather than at those directed at creating such fragmentation. Recontracting is, in fact, substantially cheaper in the latter case, reducing the need to conserve the original agreement.

These legal solutions are analogous to a gravitational force, reunifying rights that, given their strict complementarity, would naturally be held by a single owner. This tendency towards reunification works to rebundle property rights in order to regenerate the natural conformity between use and exclusion rights and more generally, between any two complementary fragments of property.

5. Conclusions: Beyond Semantic Juxtapositions

When we say that there is freedom of contracts but not of property, we contrast incomparable categories, because contracts are often the way in which property rights are created and transferred. In many ways, the distinction between property and contracts with respect to atypical arrangements makes use of semantic juxtapositions. The real question is not that of establishing where freedom of contract ends and where formalism in property begins. Freedom of contract and "numerus clausus" doctrines happily coexist in many legal systems around the world, including the Roman system that produced the *numerus clausus* doctrines. The question is that of understanding why legal systems offer property-type remedies only in a limited range of situations, and use liability-type remedies in the majority of other cases. Posed in these terms, the use of categorical distinctions confuses the real understanding of the matter.[89] Property scholars who do not consider these facts cannot make sense of the apparent anomalies in the law of property protection. Most property scholars and professors consider the presence of liability-type remedies for certain categories of real rights as merely coincidental.

[89] There are several real property situations that only enjoy liability-type protection. Yet, there are several merely contractual arrangements that enjoy property-type protection (in a way, we can also think of specific performance as the contract law analogue of property-type remedies). As all students who survived a remedies course would realize, the substantive categories of property and contracts are only very imperfect proxies for the applicable remedial categories in the case.

In the present article, I suggest that these apparent anomalies in the law of remedies are not the result of legal heterodoxy. Even setting aside the information cost explanations discussed above (indeed, such explanations may lose some of their cogency in light of conveniences afforded by new information technologies), the strong presumption against the judicial recognition of new forms of property and the various doctrines of unified property retain a solid economic justification. In evaluating inalienability-type rules and *numerus clausus* doctrines, policymakers reasonably consider the trade-off between the forgone value-increasing opportunities for the owners and the potential deadweight losses from entropy. As suggested above, atypical partitioning of property rights may be important for successful pursuit of the owners' objectives. From a laissez-faire perspective, these arrangements express the owners' freedom of contract and private autonomy. In designing legal solutions to dysfunctional property fragmentation, the critical concern should be to balance goals of efficiency with the parties' autonomy.

One-directional transaction and strategic costs lead to a relatively more liberal use of property-type remedies that favor owners of non-fragmented property; at the same time they do justify limited liability-type protection for fragmented or dysfunctional right holders. This dual approach to protection is justified by the fact that the unified owner faces no strategic impediments when deciding among alternative uses of his property, or when internally reallocating his resources. Conversely, owners of fragmented and dysfunctional property face transactional impediments that necessitate the use of liability-type remedies.

The selective use of legal remedies is analogous to an adhesive agent to overcome entropy in property. These legal mechanisms promote the reunification of rights and privileges that, given their complementarity, should naturally be held by a single owner, (re)generating the natural conformity between complementary attributes of a right (such as the right to use and exclusion others from property).

As we have seen, such doctrines have a long heritage, several of which date back to Roman times, and are found in legal systems across

a wide geographic area. During the 19th century, ideals of individual autonomy and freedom of contract led legal scholars and courts to strictly scrutinize these restrictions. As a result, modern systems in the Western legal tradition have almost universally attempted to strike a rough balance between the principle of freedom of contract and the societal interest in protecting unified property by providing different remedial protection to typical (or nominate) and atypical (or innominate) property rights. Although parties can contract without restraint, if they create atypical property rights they can only count on liability-type protection under most circumstances. The dichotomous treatment of typical and atypical property rights minimizes the social cost of entropy.

Non-conforming property rights bring the risk of governmental intervention in the regulation of private property. Regulations often lead to dysfunctional fragmentation of property rights, affect final allocation of resources, and generally produce greater inefficiencies than those resulting from the occasional miscalculation of short-sighted private owners.

The comparative analysis of both historical and contemporary legal systems clearly confirms our positive hypothesis (i.e., that courts and legislators have accounted for the asymmetric effects of property fragmentation). Not only are legal systems are reluctant to grant extensive property-type protection in favor of non-conforming property arrangements but tend to devise default reunification triggers for atypical property right arrangements.

Quite interestingly, entropy may explain the selective use of different remedies within the same entitlement or relationship. Asymmetric remedies offset the asymmetric frictions encountered in the transfer of rights. In this setting, the observed anomalies actually confirm our efficiency hypothesis, suggesting that in the presence of asymmetric strategic and transactional impediments, legal systems may provide a dichotomous treatment of legal relationships. Such rules would take the "directional" transaction costs occasioned by entropy into account (e.g., the different costs of fragmenting a unified bundle and re-bundling a fragmented one).

These directional remedies are analogous to a gravitational force, facilitating the reunification of rights that, given their strict complementarity, would best be held by a single owner. This tendency towards reunification works to re-bundle property rights in order to regenerate the natural conformity between use and exclusion rights and, more generally, between any two complementary fragments of property.

Several other rules concerning the creation and enforcement of atypical property rights can also be seen in light of the positive hypothesis of transaction and strategic cost minimization. The underlying need to contain entropy, as we have seen, explains several civilian and Anglo-American doctrines.

Economic analysis provides a valuable key for understanding the results of the present comparative and historical analysis because it helps us discriminate between the alternative solutions offered by various legal systems. Specifically it suggests that the use of inalienability-type solutions to prevent the problem of entropy is not worth it due to fact that this kind of remedy might foreclose value-enhancing exchange opportunities. Other solutions appear to be more sensible and cost-effective methods of preventing entropy because they protect individual autonomy while preserving flexibility in the use of property. Examples of this latter category include the action for partition to promote legal unity, the use of selective remedies for new forms of property, the adoption of shortened terms of liberative or acquisitive prescription, and the use of doctrines of changed circumstances, etc. In these contexts, legal rules create default reunification mechanisms which obviate the need for costly and difficult negotiations to secure release from obsolete obligations or to reunify dysfunctional property fragments. Depending on the legal system, different solutions correct the various forms of functional, physical, and legal fragmentation considered in this paper. The advantage of these solutions over the inalienability-type remedies is that, in most cases, they rely on market mechanisms, the only practical devices for promoting efficient final allocations at the micro level.

Finally, one should not forget that if all such remedies fail to accomplish their goal, governments maintain their power of eminent

domain, which may be seen as a possible, albeit intrusive, instrument for the most chronic and irreversible forms of entropy.

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