

CELESTIAL ANARCHY: A THREAT TO OUTER SPACE COMMERCE?

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The wealth-creating potential of outer space commerce is tremendous. Companies such as SpaceX are successfully providing private sector responses to public sector demands for transportation to the International Space Station. Planetary Resources and Deep Space Industries promise to create wealth by mining asteroids for rare metals and water. And Virgin Galactic and Space Adventures are pioneering the market for space tourism.

The world's first commercial spaceport, Spaceport America, in New Mexico, which cost nearly \$209 million to build, is already in use by SpaceX and Virgin Galactic. In addition, high-powered investors, such as Elon Musk (creator of PayPal, now CEO of SpaceX), Larry Page (co-founder of Google, now also involved with Planetary Resources), and Sir Richard Branson (chairman of the Virgin Group, the venture capital conglomerate behind Virgin Galactic), are pouring hundreds of millions of dollars of their own capital into outer space ventures.¹

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¹See Solomon (2012) for a historical overview of companies currently pioneering space-related commercial activities.

Yet an ominous feature of the celestial environment seems to threaten the ability of outer space commerce to achieve its potential: celestial anarchy. Although, terrestrially, governments enjoy the sovereignty over their territories needed for the state to define and enforce property rights in those territories, celestially, things are quite different. In outer space, much as in international space, no government has sovereignty. This fact is enshrined in the 1967 Outer Space Treaty, signed by the spacefaring nations. Article II of the treaty prohibits signatory nations from extending territorial jurisdiction to celestial bodies.²

In practice, at least, the same Article prevents even private citizens from using their sovereigns to define or enforce privately held property rights in celestial bodies.³ As White (2002: 84) points out, “in common law countries such as the United States, legal theory dictates that the government must have sovereignty over territory before it can confer title on its citizens. Consequently, traditional real property rights [in outer space] are inconsistent with this theory.”

The problem celestial anarchy seems to create here is straightforward. Private parties who have property disputes when operating in outer space need to settle their disputes in courts of law. But such courts are within the legal domains of national sovereigns. Enforcing private parties’ property rights in outer space therefore requires a *de facto* concession of national sovereignty, running afoul of Article II.⁴ As Pop (2000: 281) puts it, because “the Outer Space Treaty prohibits the national appropriation of outer space and celestial bodies, a State endorsement” of private parties’ property rights

²The full text of this treaty and list of signatories and parties are available at http://disarmament.un.org/treaties/t/outer_space. Because of the lack of signatories among spacefaring nations, we don’t consider here the 1979 Moon Treaty (<http://disarmament.un.org/treaties/t/moon>).

³Whether or not the Outer Space Treaty precludes private citizens from holding property rights in celestial bodies in principle is contested. Some scholars argue that some form of private property rights is reconcilable with the requirements of the Outer Space Treaty (see, for instance, Groove 1969 and White 1997, 2000, 2003). Others argue that the Treaty precludes all private property rights (see, for instance, Pop 2000 and Dunstan 2002).

⁴This is why White (2002: 84), a defender of private property rights in outer space, argues in favor of a “quasi-territorial” jurisdiction for the establishment of any kind of private property rights regime. In this sense the analysis that follows has implications for civil law nations as well.

in such bodies “would be interpreted as a means of national appropriation, hence it would be unlawful.”

Economists have long highlighted the necessity of private property rights for thriving commercial activity (e.g., Smith 1776, Mises 1949, Alchian and Demsetz 1973, North 1990). Without some means of enforcing claims to mine and thine, individuals have little incentive to risk investing in and growing commercial enterprises. This is as true for celestial enterprises as it is for terrestrial ones. As White (2000: 2) notes, “Implementing [a] real property regime would provide greater legal certainty to investors and entities participating in the development and settlement of outer space.” Celestial anarchy thus appears to pose a serious obstacle to flourishing outer space commerce.

But what if private parties sidestepped the problem posed by sovereigns’ inability to support celestial property rights by enforcing such rights *privately*—that is., without reliance on any government? Pop (2000: 281) summarizes the conventional view of this possibility: “Appropriation of land can exist outside the sphere of sovereignty, but its survival is dependent upon endorsement from a sovereign entity.”⁵ In other words, it is widely believed that a purely private celestial property rights regime is not possible.

This article argues that conventional wisdom is wrong. Celestial anarchy is genuine, but the ostensible problem it poses for the development of outer space commerce is not. Private property rights can and do survive without the endorsement or involvement of any sovereign entity. This suggests that private parties can, if given the chance, enforce property rights in outer space. Economically, at least, celestial anarchy poses no obstacle to the flourishing and full development of celestial enterprise.

The conventional wisdom’s failure to grasp this fact stems from two sources: unfamiliarity with economic theory and unfamiliarity with economic reality. Economic theory demonstrates how private individuals can enforce property rights without reliance on government. And economic reality demonstrates how they in fact do so. There’s nothing special about this theory or its manifestations in practice that would limit it to terrestrial property rights.

Our argument does not deny potential political problems associated with private individuals of particular nationalities claiming

⁵See also Coffey (2009).

property rights in outer space when those claims run afoul of sovereigns' interpretation of the Outer Space Treaty. It denies the alleged economic problem of them doing so, upon which the prevailing view that celestial anarchy threatens to undermine outer space commerce is based. In this sense, our article complements existing contributions to the literature on governance in outer space that discuss mechanisms for achieving resource usage (see Weeden and Chow 2012, Cooper 2003, Milligan 2011, and Simberg 2012). In our concluding section, we briefly consider the relevance of our analysis of the economic (non-) problem of celestial anarchy for the political problem such anarchy may pose.

Enforcing Property Rights without a Sovereign in Theory

According to conventional wisdom, a sovereign state—a monopoly authority that all parties must submit to as the final arbiter of property disputes—is necessary to enforce and thus sustain a regime of property rights. To understand this claim it's helpful to consider an analytic scenario that has done much work for economists who study the nature of governance: the Prisoners' Dilemma. Figure 1 depicts this scenario.

Alice and Bob are considering how to behave toward one another in an environment without a sovereign. The rows and columns in Figure 1 depict the strategies that Alice and Bob, respectively, can pursue in their interaction with one another. Inside each row-column box are Alice's and Bob's payoffs—that is, what each party earns by interacting with the other—depending on the strategy they pursue and the strategy the other party pursues. Alice's payoff appears first in each box and Bob's appears second.

Alice and Bob each have two strategies they may follow in their interaction with the other. They choose their strategies simultaneously. Each party can “cooperate” by respecting the property rights the other party claims to have, say by trading with the other party honestly. Or they can “defect” by violating the property rights the other party claims to have by, say, by stealing what the other party claims as his or her own or trading with him or her fraudulently.

When both parties cooperate with each other, both capture gains from trade equal to $A > 0$. When one party defects but the other party cooperates, the defecting party benefits at the cooperating party's expense. In this case the defecting party earns $C > A$, and the coop-

FIGURE 1
THE PRISONERS' DILEMMA

	Cooperate	Defect
Cooperate	A, A	B, C
Defect	C, B	0, 0

erating party earns $B < 0$. When both parties defect, both parties earn 0: mutual theft is damaging to both parties, but not as damaging to either party as being “suckered”—i.e., respecting the other party’s property rights when the other party violates their property rights.

Without a property right-enforcing sovereign to keep them in line, how will Alice and Bob behave? Examining each party’s payoff under each of the possible scenarios in Figure 1 reveals that both Alice and Bob will defect. This is because, no matter what the other party does, both Alice and Bob maximize their own payoff by violating the property rights of the other.

If Alice thinks Bob will cooperate, Alice wants to defect because she earns her highest payoff possible, C, in this scenario. If Alice thinks Bob will defect, Alice again wants to defect because she earns 0 in this scenario, which is higher than what she earns if she cooperates and Bob defects, B. Bob, whose situation is symmetric, reasons the same way. So he always defects too.

Both parties therefore earn 0, which is less than what both could earn if they could instead agree to respect each other’s property rights, A. Each party can promise the other that they will cooperate. But without a sovereign to enforce that promise, each is led to break their word, tempted by the specter of earning C if the other party keeps his or her word, or of at least earning 0 instead of B if they expect the other party to break his or her word.

This dilemma described by Figure 1 is a stylized version of that which conventional wisdom suggests must be the outcome under

celestial anarchy in arguing that enforceable property rights are unsustainable here. Consider what happens, however, if we modify the analytical situation that Alice and Bob confront in a small way that more closely resembles reality. Suppose that Alice and Bob interact, and thus have the opportunity to respect or violate one another's property rights, not just once, but an indefinite number of times—the case of a repetitive game. Suppose that both parties defect on the other party for all subsequent interactions if he or she defects on him or her even once and that both parties tell the other as much. Now how will Alice and Bob behave without a sovereign to keep them in line?

Unless Alice or Bob is excessively impatient, both will cooperate. Where $\gamma \in (0,1)$ is the discount rate that Alice and Bob apply to payoffs from interacting in the future (since earnings in the future are worth less than earnings today), for both parties, cooperation now yields:⁶

$$(1) \sum_{t=0}^{\infty} \gamma^t A.$$

And for both parties, defecting now yields C. Recalling the rule for solving an infinite geometric series and using simple algebra to solve for γ reveals that cooperating is now more profitable than defecting for both Alice and Bob when:

$$(2) \frac{A - C}{C} > \gamma.$$

As long as Alice and Bob are patient enough to satisfy this inequality (i.e., they don't discount future payoffs too steeply), both will respect the other's property rights despite the absence of a sovereign.⁷ Simply permitting Alice and Bob to interact repeatedly and conditioning each party's strategy choice on the strategy chosen by

⁶Alternatively, one can think of γ as the probability that Alice and Bob's interaction in a particular period will be their last—that is, the probability with which the game they're playing ends each period (or as a parameter that reflects Alice and Bob's discount rate and the probability with which the game they're playing ends each period).

⁷Because outer space commerce requires large up-front investments before net benefits can be secured—and even then only after repeated periods of cooperative interaction with fellow space entrepreneurs—the “space business” selects for individuals who are patient.

the other party in the past reverses the result we found earlier. Instead of always violating one another's property rights, Alice and Bob always respect one another's rights.

The reason for this result is what economists call the “discipline of continuous dealings.” The intuition that underlies it is simple. When Alice and Bob interact indefinitely rather than just once, the possibility of being “punished” by the other party in the future for defecting in the past emerges. Both parties know that if they violate the other party's property rights today, the other party will defect when interacting with them tomorrow—and in every period after that—preventing the defecting party from earning positive payoffs ever again. Since the gain from defecting is a one-time gain but the gains lost from defecting even once are forever, if parties don't discount the future excessively, they earn more by always cooperating than by ever defecting. Property rights are *self-enforcing*.

In Figure 1 there are only two parties. But the logic is the same if there are more than two. Indeed, when there are more than two parties, reputations become possible, strengthening self-enforcing property rights still further. Suppose, for example, that in addition to Alice and Bob, there's another party, Charlie. Now if, say, Alice violates Bob's property rights, not only may Bob defect when interacting with Alice in the future, cutting her off from the gains of future cooperation with him, but Bob may tell Charlie that Alice is a property right violator, leading Charlie to defect on Alice in all his future interactions with her as well. This makes the “punishment” that Alice suffers for defecting even stronger, which in turn strengthens her incentive to respect Bob's and Charlie's property rights.

The discipline of continuous dealings illustrates theoretically why a sovereign isn't necessary to sustain enforceable property rights. In what follows we draw on economic reality to illustrate how private parties leverage self-enforcing property rights without a sovereign in practice. Although there are many examples we could draw on for this purpose (see, for instance, Friedman 1979; Ellickson 1994; Anderson and Hill 2004; Leeson 2007a, 2007b, 2009, 2013), we focus on one in particular because of its similarity in several important respects to the situation of celestial anarchy this article is interested in—namely, international anarchy.

Enforcing Property Rights without a Sovereign in Practice

International anarchy refers to the fact that, although globally many sovereigns exist to define and enforce property rights among persons engaged in commerce in each of their domestic domains, no formal supranational sovereign exists to define and enforce property rights among persons engaged in international commerce—commerce between citizens hailing from different territories governed by different national sovereigns. Nor has such a sovereign ever existed. In this sense the property rights situation that parties to international commerce confront is similar to the property rights situation that prospective parties to outer space commerce confront.

Yet international anarchy hasn't prevented international commerce from flourishing. In the absence of a supranational sovereign that could create a sustainable property rights regime for international traders, international traders have developed a private regime of self-enforcing property rights for this purpose instead. The result has been booming international commerce that generates nearly a quarter of the world's wealth annually. Central to this regime of self-enforcing property rights is the discipline of continuous dealings described above.⁸

The Medieval Law Merchant

In the ninth and tenth centuries a professional class of merchants emerged across Europe. These merchants confronted the central obstacle of international anarchy pointed to above: the absence of a supranational sovereign that could protect international traders' property rights, enabling the growth of international commerce. Given this situation, if a trader from Italy entered a commercial contract with a trader from Spain, how could their contract, and thus the property rights embodied in that agreement, be enforced?

A trader who believed his counterparty had violated their agreement might attempt to seek enforcement against his counterparty in his nation's courts. But such courts typically refused to adjudicate international cases on the grounds that they involved citizens from

⁸However, this isn't the only mechanism of self-enforcing property rights that international traders rely on. For a discussion of a second mechanism—one rooted in signaling—see Leeson (2006a, 2008a).

other nations, over whom they had no jurisdiction. Even if one agreed to adjudicate such a case, since it lacked authority over the counterparty, who was from another country, it had no means of enforcing its decision. An Italian court, for example, couldn't seize the assets of a merchant located in Spain. Further, on the basis of which sovereign's law should such a court adjudicate the traders' disagreement? The laws created and enforced by the government of Italy to govern Italian citizens didn't (and don't) apply to Spanish citizens governed by Spanish law.

In response to such obstacles to international commerce, medieval merchants resolved international commercial disputes privately on the basis of merchant-developed law in private, merchant-developed courts. This system of self-enforcing property rights is called the medieval *lex mercatoria* (law merchant). As Benson (1989: 645) notes in his discussion of the medieval law merchant, this system demonstrates that international "commerce and commercial law have developed conterminously, without the aid . . . of the coercive power of nation-states."

Although initially based on what knowledge of Roman civil law had been salvaged after the fall of the Roman Empire, the medieval law merchant evolved as customs and practices common to many geographic locales became standard practice for merchants engaged in international commerce (Benson 1989: 648). Common rules enabled merchants to capture more of the gains from international trade, further cementing them as a cornerstone of acceptable practices among international traders.⁹ By the 12th century, international "commercial law had developed to a level where alien merchants had substantial protection in disputes with local merchants" (Benson 1989: 648).

The private merchant courts that adjudicated property conflicts under this body of private law developed their own rules of evidence and employed experts to decide specialized matters involving international commercial contracts. Compared to the national courts prevalent in the nascent sovereigns of the period, merchant courts were informal and reached decisions quickly—a feature valued highly by international merchants (Benson 1989: 649–51).¹⁰

⁹This "snowballing" effect whereby the success of least-cost norms and behaviors further entrenches their common usage is a hallmark of spontaneous social institutions, such as the common law, language, and even the use of money.

¹⁰See also Milgrom et al. (1990).

To enforce merchant court decisions, members of the international commercial community leveraged the discipline of continuous dealings described earlier. Although these courts had no formal enforcement power, most traders complied with their decisions. Refusing to do so resulted in the members of the international trading community blacklisting the uncooperative traders, cutting them off from the benefits of future trading opportunities with members of that community. The discipline of continuous dealings between international traders rendered commercial contracts between them, and thus traders' property rights, self-enforcing.

The Modern Law Merchant

In the absence of a supranational sovereign to enforce and sustain property rights between contemporary international traders, modern international trade is similarly governed privately—by a modern law merchant. Given the difficulties, and for many years the impossibility, of using national sovereigns to enforce international commercial disputes, contemporary international traders rely on private international arbitration associations instead. Indeed, at least 90 percent of modern international commercial contracts contain clauses stipulating the resolution of contractual disputes via private arbitration (Leeson 2008b: 68).

The sums of money at stake in these private courts are enormous. For example, in 2001 roughly 1,500 parties from 115 countries used the arbitration services of the International Chamber of Commerce (ICC), the largest of such organizations, in property conflicts that ranged in value from \$50 to \$1 billion. Over 60 percent of these disputes were for amounts between \$1 million and \$1 billion (ICC 2002). Likewise, in 2001 another private international arbitration association, the International Center for Dispute Resolution (ICDR), adjudicated contracts worth \$10 billion involving parties from 63 different countries (ICDR 2002).

When forging their contracts, parties to private international arbitration choose the law they want to apply to their agreement in the event of dispute. They may choose commercial law as embodied in the laws of various sovereigns. Or they may choose to have customary law, as it has evolved and developed under the modern law merchant, to govern their contracts instead.

Like those of their medieval merchant-court counterparts, the decisions of private international arbitration associations are over-

whelmingly respected by the international traders who rely on them. The ICC, for instance, estimates that 90 percent of its decisions are complied with voluntarily (Leeson 2006b: 50). As in the past, the discipline of continuous dealings plays a crucial role in securing such compliance and rendering property rights self-enforcing. A trader who refuses to comply with the decision that one of these private courts has handed down to him faces losing his reputation among the community of international traders, and with it, the prospect for future commerce.

In 1958 the first multinational treaty aimed at facilitating the enforcement of private international arbitral decisions in the national courts of sovereigns emerged: the United Nations New York Convention on the Recognition and Enforcement of Foreign Arbitral Awards. Since then, many, though not all, countries have signed the New York Convention (NYC). Leeson (2008b: 63) describes how the NYC works:

Private parties to international commercial contracts agree to have their disputes settled by arbitration associations. Since these associations are private, they cannot formally compel losers to comply with their decisions. However, under the terms of the NYC, winners can have their arbitral decisions enforced by losers' governments if these governments are members of the convention. . . . A simple example illustrates how the NYC provides state enforcement for international traders. Suppose a Bulgarian importer contracts with an Argentinian exporter for a shipment of grade A quality leather. When the shipment arrives, the Bulgarian finds that the leather is only of B quality, though his trade partner insists it is A. Before 1958 these traders would have privately settled their dispute through an international arbitration association. If the arbitrator decided the Argentinian did not fulfill his end of the contract and ordered him to pay, the Bulgarian had no means of compelling payment should the Argentinian refuse. However, the introduction of the NYC in 1958 changed this. Traders still use private arbitration to settle disagreements. But now, under the NYC, if the Argentinian refuses to pay, the Bulgarian can call on the Argentinian government, which has signed the NYC, to enforce his arbitral award.

Because of the NYC, at least in principle, post-1958 international traders have been able to rely on the support of sovereigns to enforce

their property rights. But it would be mistaken to conclude that the NYC has succeeded in removing international traders from international anarchy and thus that international commerce requires, or indeed is ultimately based on, sovereign enforcement. Prior to 1958 the NYC didn't exist. Yet international commerce, which was already substantial, flourished. Equally important, in the absence of a supranational sovereign, the NYC—which is a contract between sovereigns—itself has no sovereign that could enforce its terms. What enforces the NYC's terms is the discipline of continuous dealings.

The NYC is nothing but a statement of promises from its sovereign signatories to agree to respect private international arbitral awards rendered by other sovereigns. No third-party enforcement of these promises exists, or in the absence of a global government is possible. To the extent that sovereign signatories of the NYC fulfill their promises under the treaty, they do so under the threat of being ostracized by the Convention's other signatories who may refuse to enter into future treaties with a sovereign that goes back on its word.

Thus, even in the case of the NYC, the discipline of continuous dealings—ultimately a mechanism of self-enforcement—drives compliance. As Leeson (2008b: 83) puts it, “Like all multinational treaties, for the NYC as well, there is no formal supranational agency of authority to compel states that have joined it to abide by its terms. This leaves the enforcement of the NYC to informal mechanisms, such as reputation, and the interstate equivalent of international arbitration through such organizations as the UN.”

Conclusion

The economic theory of self-enforcing property rights and the economic reality that illustrates this theory's application under international anarchy suggests that conventional wisdom, according to which a sustainable property rights regime under celestial anarchy isn't possible, is mistaken. If there are special features of the celestial environment that preclude our analysis' relevance for this environment, we can't think of them—and the absence of an enumeration of such features by others suggests they can't either.

This statement does not, of course, deny that special, particular features of the outer space environment that would bear on how privately created governance might emerge in this context exist.

For example, self-enforcing property rights in international traders' anarchic context differ from their manifestation in the anarchic, 19th century American frontier (which we did not consider, but see Anderson and Hill 2004). These differences reflect specific features of the property rights problem situation that individuals confronted in each case. Likewise, the particular property right problems that outerspace entrepreneurs may confront will also surely be different, suggesting that the precise way in which self-enforcing property rights would manifest in this anarchic environment differ too.

Perhaps commercial space pioneers would use already-existing arbitration associations, such as the ICC, in order to enforce celestial property rights. Or perhaps a body of private outer space law—informed at its core by familiar precedents relating to nuisance, damages, liability, and so on—might progress to the point that space-specific arbitration agencies, employing their own experts in space law, would serve as the primary dispute resolution mechanism and process by which precedent is set. Alternatively, the first space pioneers might have a voluntary convention in which their representatives form a kind of outer space “social contract,” thereby setting the rules for original appropriation of unowned resources, property rights enforcement, and the proper bounds of behavior between parties when one party's behavior imposes uncompensated burdens on others.

The specific self-enforcing arrangements that might actually develop under celestial anarchy can't be established with any certainty *ex ante*. What can be established is that some system of self-enforcing property rights would develop if given the chance and that such a system would reflect the particular issues that space entrepreneurs confront in their efforts to secure the substantial gains that cooperative celestial commercialization offers.

As economists, our comparative advantage is analyzing the economic problem that celestial anarchy seems to, but, as our analysis suggests, does not in fact, pose for sustaining enforceable property rights in outer space. Nevertheless, in concluding we think it worthwhile to touch briefly on the implications that our analysis may have for the potential *political* problem posed by celestial anarchy. That problem is this: There may be political consequences to private individuals' securing property rights in outer space if these individuals' claims run contrary to political actors' interpretation of Article II of the Outer Space Treaty.

We have in mind here something along the lines of political elites in country X, in response to the establishment of property rights in celestial bodies in a manner consistent with what we have described in this article by an individual citizen of country Y, objecting that such an establishment violates the “genuine intent” of the Outer Space Treaty. Such objections could escalate into tensions between the sovereign nations of which X and Y are citizens. And those tensions may have further political consequences.¹¹ Our finding that the economic problem of celestial anarchy is actually not a problem could help diffuse such a situation. To the extent that political elites are interested in seeing the establishment of private property rights in space so that commercial space activity can flourish, but worry that this must involve violating the sovereignty restrictions in the Outer Space Treaty, our analysis shows their concern is misplaced.¹²

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¹¹We don’t wish to ascribe empirical content to political elites’ motivations. Perhaps political elites in country X believe the arrangement entered into by the individual citizen of country Y violates the spirit of the treaty, and thus is an injustice requiring rectification. Alternatively, these political elites may make threatening gestures in the hope that they will be compensated with some of the wealth generated by commercial space activities entered into by the citizen of country Y and his or her co-parties. Both of these scenarios, and countless others, are plausible.

¹²In doing so, our analysis also frees up intellectual and physical resources that might otherwise be spent devising unnecessary rationales for the de facto extension of sovereignty to celestial bodies.

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