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HOW TO REDUCE TRANSACTION COSTS IN SPECTRUM MARKETS

By Joe Kane

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INTRODUCTION

All wireless devices rely on access to radio frequencies over which they send and receive data. In the United States, private access to the radio spectrum is controlled by the Federal Communications Commission (FCC), which licenses spectrum users. The FCC is currently moving toward allocating mid- and high-band spectrum that has not yet been a major component of commercial wireless services. As the wireless market grows, the FCC will need to consider how the regulatory regime that governs spectrum licenses may help or hinder the connectivity of tomorrow. And as private companies move into new bands, the FCC must ensure that conditions are ripe for an innovative and dynamic marketplace

One of the most significant barriers to this robust spectrum marketplace of the future is the existence of transaction costs that inhibit the ability of frequencies to be used productively. Accordingly, this paper seeks to evaluate alternative allocation schemes in light of the transaction costs they elicit and suggests concrete policy reforms that would reduce these costs, thereby enhancing the efficiency of markets for the benefit of everyone who uses wireless services.

SECONDARY SPECTRUM MARKETS AND TRANSACTION COSTS

In recent decades, the FCC has rightly begun to shift away from command-and-control regulation and toward facilitating markets for spectrum.[1] This means that the agency often auctions off relatively flexible spectrum licenses. The rights granted by those licenses can sometimes be sold in secondary markets—that is, outside parties can purchase them from the original licensees. Secondary market transactions take place through FCC-mediated auctions[2] and private acquisitions.[3] The second of these two types of secondary markets is the focus of this paper.

To help the FCC facilitate the creation of more efficient secondary markets, this paper examines two potential sources of transaction costs and ways to mitigate them. First, it looks at how the FCC selects the initial sizes and shapes of license areas before they even reach the marketplace, a decision that can have a significant effect on the transaction costs that parties to market transactions encounter downstream. Second, it discusses ways to improve the operational efficiency of the spectrum market once it has been created.

As with any scarce resource, markets are key to allocating spectrum licenses in a way that produces efficient outcomes. But market transactions do not automatically produce such outcomes; rather, efficiency often depends heavily on the

1. See, e.g., Joe Kane, "The Role of Markets in Spectrum Policy," *R Street Policy Study* No. 146, June 2018. https://2o9ub0417chl2lg6m43em6psi2i-wpengine.netdna-ssl.com/wpcontent/uploads/2018/06/Final-No.-146-for-posting.pdf.

2. "Broadcast Incentive Auction and Post-Auction Transition," Federal Communications Commission, May 9, 2017. https://www.fcc.gov/about-fcc/fcc-initiatives/incentive-auctions.

3. See, e.g., Colin Gibbs, "Verizon to acquire Straight Path for $3.1B, ending bidding war with AT&T," FierceWireless, May 11, 2017. https://www.fiercewireless.com/wireless/verizon-to-acquire-straight-path-for-3-1b-ending-bidding-war-at-t.

initial conditions of the market.[4] Since the institutional constraints on these conditions are often synonymous with FCC policy, the agency should approximate initial conditions that will create flexibility and lower transaction costs so that productive outcomes can prevail in the long run.

DEFINING LICENSE AREAS

Currently, each reallocation proceeding at the FCC considers anew how to design license areas for a particular band, resulting in areas of varied sizes and shapes.[5] In the absence of transaction costs, the initial license size and shape would be irrelevant to the outcome; there would be no difference between disaggregating a large license area into smaller ones or aggregating several smaller areas to make the ideal license size and shape for any given application. But transaction costs—in the form of the time, energy and money required to identify a beneficial exchange, negotiate an agreeable price with all the involved parties and reshuffle the rights so that the exchanged resources can be used—are ubiquitous in the real world, meaning that the design of the initial license areas will affect the secondary markets. Therefore, determining the optimal initial allocation of spectrum license areas is vital to long-run productivity.

The size and shape of the geographic areas covered by these licenses is inevitably the subject of much debate. Some, like the five "regional PCS areas,"[6] are gargantuan and few in number, while others, like the individual areas defined by the over 3,000 separate counties, are smaller and more numerous. License areas also come in many shapes, ranging from geometric forms like rectangles to more irregular forms based on geography and population centers. Understandably, various parties try to push the FCC toward selecting the geographic size and shape most suited to their preferred application. The recent Citizens Broadband Radio Service (CBRS) proceeding in the 3.5 GHz band, for example, largely ignited a debate about whether license areas should be defined based on partial economic areas or census tracts.[7] In the end, the FCC went with the compromise of license areas based on counties.

The initial choice of license size and shape presents many tradeoffs, some of which are foreshadowed in literature concerning the initial conditions in markets for land. Today, the government does not generally assign size and shape to plots of land; instead, market transactions allow it to be divided or combined into customized plots for any number of uses. However, the initial conditions governing plots of land can still have lasting effects on the marketplace.

The Case of Georgia

We can get a sense of the manner in which initial conditions of land plots affect outcomes through Hoyt Bleakley's and Joseph Ferrie's analysis of a natural experiment that took place in the U.S. state of Georgia during the early 19th century.[8] At that time, Georgia sought to implement a method of allocating land that limited the ability of individuals to game the system in their favor. The state decided to divide a large area of land into relatively small rectangular plots and distribute these plots via lottery. The land in the lottery zone was, in that way, different from the land just outside of the zone, which consisted of much larger, irregularly shaped plots.

Bleakley and Ferrie examined the outcome of this lottery and the differences that developed between the plots in the lottery zone and those in the neighboring area over time. Ultimately, they concluded that the way this allocation system was implemented was suboptimal because it caused coordination and holdout problems. Since many plot owners would seek to increase the size of their plots, they would look to buy portions of neighboring plots. But the owners of those neighboring plots also wanted to increase their plot sizes. Making one plot larger moved it closer to the optimal size, but it also made neighboring plots smaller in relative terms and thus further from optimal. Therefore, the initial lottery allocation of small, rectangular plots made it unlikely that bilateral deals would take place. Multilateral deals, in which plot owners who surrounded a central plot attempted to divide it up so that all of their plots ended up closer to the optimal size, were even more complicated because of the transaction costs that result from the possibility of holdouts (discussed in more detail below). Overall, then, the small, rectangular nature of the original plots cut against efficient market operation after the lottery. Bleakley and Ferrie observe that land in the lottery area still exhibited the distortions from this initial allocation 150 years later.

Georgia's system did involve some positive elements that contributed to market efficiency. The most useful one for our purposes was the publication of a list of lottery winners to facilitate market transactions by connecting potential buyers with current plot owners. While the list became outdated quickly, it did increase the rate of turnover for the assigned lots. The lessons learned from this aspect of the Georgia land lottery are especially applicable to spectrum markets.

4. Ronald H. Coase, "The Problem of Social Cost," *The Journal of Law and Economics* 3 (October 1960). https://econ.ucsb.edu/~tedb/Courses/UCSBpf/readings/coase.pdf.

5. "Auction Maps," Federal Communications Commission. https://www.fcc.gov/economics-analytics/auctions-division/auctions/auction-maps.

6. "Regional PCS Areas (RPC)," Federal Communications Commission. https://www.fcc.gov/sites/default/files/wireless/auctions/data/maps/rnpcs.pdf.

7. "In the Matter of Promoting Investment in the 3550-3700 MHz Band," Federal Communications Commission, Oct. 23, 2018, ¶¶ 9–41. https://ecfsapi.fcc.gov/file/10242030623468/FCC-18-149A1.pdf.

8. Hoyt Bleakley and Joseph Ferrie, "Land Openings on the Georgia Frontier and the Coase Theorem in the Short- and Long-Run," Working Paper, March 27, 2015. https://economics.sas.upenn.edu/sites/default/files/filevault/event_papers/draft_v2.3.pdf.

Of course, initial allocations of land or spectrum will never be perfect, and the optimal size and shape will change over time. The goal of any allocation policy, therefore, should be to develop initial conditions—i.e., sizes and shapes of the plots of land or license areas—that minimize the transaction costs of future rights-trading so that these rights can be adapted to new economic and technological circumstances.

License Shape

An important consideration in determining license areas is the shape in which to draw the boundaries. Policymakers setting the initial boundaries for plots of land often face this question. As Gary Libecap and Dean Lueck note, there is a tradeoff between setting land boundaries that are easy to draw on paper and those that are most useful in practice.[9] It may be easy for the government to divide land on a map into rectangles, for instance, but in practice, natural topology may lend itself to more irregular shapes. A straight line on a map may end up dividing land on both sides of a winding river or mountain range, whereas a line following the natural features of the land would appear irregular on paper but make more sense on the ground.[10]

Applying this logic to spectrum in our contemporary context leads to a similar conclusion. Moreover, modern surveying methods have reduced the cost of discerning natural landmarks, and the Census Bureau has created well-known and well-defined boundaries based on a combination of natural and political subdivisions (e.g., census tracts, counties, economic areas, etc.). Since these boundaries often correspond to the way population centers have developed, and providing service to areas with customers in them is more important than providing it to all geographic areas, boundaries based on political subdivisions—though irregular on paper—are useful to licensees seeking to provide wireless services to consumers in a given area. Defining license sizes along these boundaries is also a useful way to avoid conflict between overlapping licenses and to minimize the dead space that a licensee does not need. All of these aspects of geographic and politically defined boundaries reduce transaction costs and thus allow secondary markets to work more efficiently.

What's more, all of this is not merely theoretical; the FCC is currently facing the question of license shape in ongoing proceedings, such as the rationalization of the 2.5 GHz band.[11] In this band, the license areas are defined as circles with a 35-mile radius centered on a transmission station. This makes a certain sense because radio frequencies propagate in all directions, forming circular license areas. But these areas sometimes overlap, creating interference disputes. This has resulted in FCC proceedings that "split the football"—that is, they divide two licenses along a line drawn between the two points at which the conflicting licenses intersect.[12] This blunt policymaking instrument detracts from licensees' flexibility to determine areas to serve based on where the customers are and to make deals to decide how much interference each party will accept in a given area.

License Size

Economic literature commonly finds that, in the context of land, the relationship between plot size and plot price increases at a decreasing rate.[13] In other words, large plots of land are generally more valuable than smaller ones, but only to a point. Intuitively, this is clear from the fact that it is not profitable for one person to buy all the land in the world. The economic reasons for this again come down to transaction costs, which make it difficult to assemble various plots of land, as well as the prevalence of substitutable plots and the fact that the quality of the marginal unit of land decreases over time.

Michael Heller observed problems with rights being too numerous or fragmented in post-Soviet real estate markets.[14] Those conditions are analogous to the problems presented by very small spectrum licenses. In both cases, the costs associated with making a deal with a large number of interested parties can become prohibitive. And even if almost all rights-holders agree to sell their rights, the ability of one or a few parties to hold out for extraordinarily high prices is a serious concern.

The holdout problem can be seen in a simple example. Suppose an entrepreneur has a business plan that requires assembling 100 separately owned spectrum licenses in a certain area to make a profit of $1,000. The entrepreneur will pay up to $1,000 to get those licenses. Suppose that

9. Gary D. Libecap and Dean Lueck, "The Demarcation of Land and the Role of Coordinating Property Institutions," *Journal of Political Economy* 119:3 (June 2011). https://economics.yale.edu/sites/default/files/files/Workshops-Seminars/Economic-History/libecap-120416_2.pdf.

10. Libecap and Lueck, however, found that land allocation in the 18th-century United States was better served by the certainty of geometrically defined plots that could be objectively marked on maps. While topographically defined plots offer greater flexibility, they argue that this benefit was offset by the difficulty of permanently defining rights based on terrain. Ibid., pp. 455–61. https://economics.yale.edu/sites/default/files/files/Workshops-Seminars/Economic-History/libecap-120416_2.pdf.

11. "In the Matter of Transforming the 2.5 GHz Band," Federal Communications Commission, May 10, 2018, pp. 11–19. https://ecfsapi.fcc.gov/file/0510125420096/FCC-18-59A1.pdf.

12. Ibid., p. 3

13. See, e.g., Peter F. Colwell and C.F. Sirmans, "A Comment on Zoning, Returns to Scale, and the Value of Undeveloped Land," *The Review of Economics and Statistics* 75:4 (November 1993). https://www.jstor.org/stable/2110041?seq=1#page_scan_tab_contents; and Tzu-Chin Lin and Alan W. Evans, "The Relationship between the Price of Land and Size of Plot When Plots Are Small," *Land Economics* 76:3 (August 2000). https://www.jstor.org/stable/3147036?seq=1#page_scan_tab_contents.

14. Michael A. Heller, "The Tragedy of the Anticommons: Property in the Transition from Marx to Markets," *Harvard Law Review* 111:3 (1998). https://repository.law.umich.edu/cgi/viewcontent.cgi?article=1608&context=articles.

the incumbent licensees only value their own licenses at $5 each. If the entrepreneur offers each of them $6, everyone wins. But if all but one incumbent accepts the $6, and the entrepreneur spends $594 to acquire those licenses, the last incumbent could demand up to $406 and the entrepreneur's project would still be profitable. While it would be in the entrepreneur's interest to pay the $406, that last incumbent could always demand more. It only takes a few incumbents demanding more than the marginal value of their licenses before the project is no longer profitable. And, in that case, the reallocation never happens; the project never takes place.

In short, licenses that start out too small can result in too many owners of exclusive rights and lead to an anticommons tragedy in which gridlock keeps the market from functioning.[15] In these cases, the transaction costs of negotiating with every rights-holder are simply too high for the deal to be worthwhile to anyone.

Compared to land, spectrum presents an even greater concern. Radio waves cannot be forced to respect imaginary lines on a map, so there will necessarily be either interference or diminished signal strength near the boundaries of license areas. Smaller, more numerous licenses mean more boundaries between license areas. Therefore, not only do small license areas raise transaction costs, they also degrade the overall productive potential of spectrum.

Nevertheless, small spectrum licenses have been proposed in various circumstances, often with the justification that they would allow the market to run its course more easily. Australia, for instance, proposed creating tiny "postage stamp" license areas.[16] And in a CBRS proceeding in the United States, several parties sought to designate the license sizes as census tracts, close the smallest geographic area available.[17] Such plans would have been deleterious to a productive outcome by creating hundreds of thousands of boundaries on which the aforementioned downsides would occur.[18] They would also fail to generate the benefits of personalized licenses in individual venues, like hotels or factories, touted by supporters of census-tract licenses, because the license areas would still be too big to cover a single business. In contrast, larger licenses that can be disaggregated easily would allow a venue to purchase a license that is exactly the size and shape it needs.

15. Ibid, p. 624

16. Lawrence M. Ausubel and Paul R. Milgrom, "Ascending Auctions with Package Bidding," *Frontiers of Theoretical Economics* 1:1 (2002), p.4. https://cowles.yale.edu/sites/default/files/files/koopmans/milgrom1.pdf.

17. "In the Matter of Promoting Investment in the 3550-3700 MHz Band," ¶ 11. https://ecfsapi.fcc.gov/file/10242030623468/FCC-18-149A1.pdf.

18. "Reply Comments of R Street Institute to the Federal Communications Commission," GN Docket No. 17-258, Jan. 29, 2018. https://2o9ub0417chl2lg6m43em6psi2i-wpengine.netdna-ssl.com/wp-content/uploads/2018/04/3.5-GHz-Reply-Comments-1.pdf.

While both of these plans were later abandoned, they illustrate that misunderstandings of the problem of anticommons tragedies is still prevalent in the spectrum policymaking world.

POLICY RECOMMENDATIONS

Draw Large Licenses that Track Preexisting Boundaries

Applying the insights from land markets to spectrum yields some promising policy recommendations for the initial allocation of license areas. As the Georgia land lottery and post-Soviet real estate examples illustrate, a good starting point for the FCC in designing license size and shape would be to draw boundaries based on partial economic areas. These licenses would cover relatively large areas with boundaries that conform to pre-existing political and population-based subdivisions. The FCC should also try to follow naturally occurring boundaries—including those of population centers and topography—rather than arbitrary geometry when designing license areas. In fact, the FCC has already proposed switching from circular license areas to those based on ready-made boundaries grounded in geography and population, like collections of census tracts or counties.[19] This arrangement would better fit the conditions on the ground and enhance the productivity of the bands.

Once these boundaries have been designated, the spectrum market would benefit from the FCC taking a hands-off approach and allowing market actors to freely customize license shapes and sizes. As is the case with the government vis-à-vis land sales, the FCC should have little influence over the geographic area covered by a license purchased on the secondary market or the contracts dividing or combining licenses to create efficiently sized areas. Since working through the complicated FCC database raises the cost of participating in secondary market transactions, the FCC should also take note of the relative success of the Georgia land lottery's publication of winners and seek to make matching potential buyers and sellers as easy as possible.

Common Ownership Self-Assessed Tax

Specifying the right geographic sizes and shapes for initial spectrum licenses is only the start of improving the functioning of the spectrum market; the real benefits come from a robust, ongoing secondary market. Just as it would be wasteful for the government to continuously seize and re-auction land after its initial allocation, rights to use radio frequencies should be bought and sold on the market without FCC interference. This means that FCC auctions should be one-time

19. Ibid., p. 7.

affairs that get bands into the marketplace, and the licenses at auction should be flexible and perpetual in duration.

Perpetual licenses do not necessarily mean that the current license-holders will dominate the market forever. Rather, they mean that licensees will be able to divide up and sell all or some of their rights over time as different use cases become more or less productive. Licensees will also bear the opportunity cost of not engaging in such transactions.

But, as we have seen, market transactions are subject to costs and, as with license shape and size, the institutional structure of secondary spectrum markets will affect the outcome. The FCC's current spectrum regime is often characterized by inflexible licenses that require cumbersome administrative procedures to repurpose. Even when licenses are flexible enough for secondary markets to work, bureaucratic barriers can make matching willing buyers and sellers difficult.

Some ways to lower transaction costs, and thus increase the viability and efficiency of spectrum markets, include lowering the barriers to locating a willing seller, determining a mutually agreeable price and closing the transaction with the FCC's blessing. Economists Paul Milgrom, Glen Weyl and Lee Zhang have proposed a novel approach to doing so: They suggest that every licensee should be granted a perpetual right over his spectrum and given a great deal of flexibility and discretion over exactly how his rights are defined.[20] However they choose to define those rights, licensees must then publicly assign them a dollar valuation. The licensee is then compelled to sell the rights to anyone who offers that amount.

Licensees may of course seek to deter potential buyers by setting a very high price on their licenses, but under this proposal, they are disciplined by a small tax on the self-assessed valuation. So if a licensee sets the price too high to avoid a sale, he ends up paying more in taxes than he would like. If he sets it too low to avoid the tax, he risks a buyer snapping up the spectrum at the cheap price. The dominant strategy, therefore, is for the licensee to accurately report his valuation of the spectrum. In later work with Eric Posner, Weyl has dubbed this system "common ownership, self-assessed tax (COST)."[21]

While gaining insight into how much spectrum users value their rights is helpful, the main benefit of this system would be to enable secondary markets to operate with much lower transaction costs than they presently do. Currently, it is quite difficult to identify which spectrum bands might be good candidates for reallocation to different uses. Often, a months- or years-long FCC proceeding is needed to legally permit spectrum licenses to change hands. Even when secondary-market transactions are allowed, it is cumbersome to work out the details of a contract and conduct rounds of negotiations. All of these transaction costs add up, ultimately reducing the number of exchanges that can be profitably carried out within spectrum markets. The result is that spectrum gets stuck in unproductive configurations, to the detriment of all parties.

The COST proposal would import and improve on the publication of the winners of the Georgia land lottery by making clear offers for spectrum rights sales publically available at all times, thus dramatically reducing transaction costs associated with locating and negotiating with incumbents. Rather than having to hire lawyers, contact the licensee and file with the FCC, someone who wants to buy spectrum in a particular area or frequency band could simply look up the price for rights to that spectrum, decide if they are willing to pay that price and then acquire the rights by paying the price.

Some may object to this plan by claiming that it creates too much uncertainty for incumbent licensees, but the self-tax mechanism actually navigates this problem quite well. Incumbents can always insulate themselves from losing their current rights by reporting a higher value for it. Though by doing so, they will incur a higher tax burden, if the existing use is in fact the most valuable, then paying an additional fee is worthwhile. And, if an incumbent cannot profitably sustain the higher valuation of his spectrum without it being bought and repurposed, then allowing spectrum to remain in that unproductive use imposes a cost to the market as a whole. If another company is willing to pay more (including the sale price and the fee paid on the later valuation) for a given band, then allowing that company to control that band enhances the overall efficiency of spectrum. After all, the aim of spectrum policy ought not to be protecting the private interests of any one party; it should be to facilitate a market in which parties can compete.

One could also conceive of the COST mechanism being used in other applications within spectrum policy. For example, licensees could be made to publish the amount of out-of-band interference their operations can handle and pay a tax on the inverse of this amount (i.e., accepting more interference would mean a lower tax burden). Such a system would incentivize innovation in filtering technology, which would create more fault-tolerant systems and allow more intensive use of each band.

There may be some concern about more ambitious proposals to extend the COST system to the whole economy in a way that would undermine property rights as we know them. But regardless of the merits of that claim, the case of spectrum

20. Paul Milgrom et al., "Redesigning Spectrum Licenses," *Regulation*, Fall 2017. https://object.cato.org/sites/cato.org/files/serials/files/regulation/2017/9/regulation-v40n3-3.pdf.

21. E. Glen Weyl and Eric Posner, *Radical Markets* (Princeton University Press, 2018), p. 61.

does not seem susceptible to it. Spectrum is not a traditional good over which traditional property rights exist. This is partly because of twentieth-century overregulation, but it is also inherent in the nature of spectrum itself. There is considerable debate over whether spectrum is a "thing" that one can own, and the balance of the evidence suggests that it is not.[22] Rather, no one really owns spectrum per se; instead, a licensee simply owns the right to operate radio equipment in certain areas in certain ways. Compared to historical allocation of spectrum and given the nature of spectrum itself, it would not be excessively radical to apply a COST system to it.

Potential Drawbacks

Since this system has never been implemented in practice, there could be unintended consequences. We would largely have to wait and see how players in the market react to a changed incentive structure. For example, investment could be skewed toward improvements to a band that are less visible to outside observers, thus increasing the private value of the spectrum without commensurately increasing its public value or, in turn, its tax burden.

The implementation of the COST mechanism should therefore be evaluated in comparison to other potential reforms to secondary markets. Making all licenses maximally flexible; creating an updated, easy-to-use computer system for use by buyers and sellers; and allowing private sales without FCC interference are all other potential reforms that Congress and the FCC could implement. These reforms would provide many of the same benefits as the COST mechanism.

We must also consider that the reason the above reforms have not been implemented is largely the result of the political machinations of the FCC operating within the agency's current statutory framework. Changes to the status quo will be shaped by the legal requirements and rent-seeking efforts of private interests, meaning that the ideal version of any reform is unlikely to be obtained. We must therefore evaluate reform efforts by what they would be likely to achieve rather than what we would like them to achieve.[23]

The COST system would certainly be a departure from the types of spectrum regulation the FCC has undertaken in the past, but in any event, experimentation to facilitate a more efficient and dynamic secondary market should be a priority for the agency.

CONCLUSION

The current market for rights to radio frequencies is far from ideal. There are numerous sources of transaction costs that reduce the ability of buyers and sellers to conclude deals that will benefit consumers of wireless services. Given its role as a spectrum regulator, the FCC has the power to set initial conditions of spectrum licenses that it auctions. Markets for these licenses would work more efficiently if their starting size is relatively large and their borders track preexisting natural and population-based boundaries. The FCC and Congress should also work together to experiment with innovative market designs, such as the COST mechanism, that have the potential to dramatically reduce transaction costs.

Wireless applications are becoming increasingly prevalent in the world economy, and the United States needs a spectrum market that can adapt nimbly and provide the dynamism the wireless future requires. Accordingly, the FCC should use its regulating authority to foster this kind of market.

ABOUT THE AUTHOR

Joe Kane is a Technology and Innovation Policy Fellow with the R Street Institute, where he works primarily on internet, telecommunications, antitrust and intellectual property issues, arguing for regulatory frameworks that promote long-term innovation.

22. Kane, p.4. https://2o9ub0417chl2lg6m43em6psi2i-wpengine.netdna-ssl.com/wpcontent/uploads/2018/06/Final-No.-146-for-posting.pdf.

23. See, e.g., Harold Demsetz, "Information and Efficiency: Another Viewpoint," *Journal of Law and Economics* 12:1 (April 1969). https://www.journals.uchicago.edu/doi/10.1086/466657.