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The explosion of wireless telecommunications in the United States is transforming the way Americans conduct their personal and professional lives. Enabling this growth has been an evolving set of policies directed toward the supply of spectrum – the *sine qua non* – of wireless telephony. Over just the past two decades the national policy has moved away from allocations of spectrum based on governmental fiat to more efficient market-oriented auction mechanisms. The need for “new” spectrum for wireless communication is, however, rapidly expanding in the face of the seemingly insatiable appetite by Americans for wireless communications.

It is against this backdrop that the National Broadband Plan (NBP) recommended making 500 MHz of additional spectrum available for commercial use to promote broadband innovation and competition.¹ One of the Federal Communications Commission’s (FCC’s) first steps in this direction is an attempt to move 120 MHz of spectrum from broadcasting to more liberally-licensed and, presumably, higher-value uses. The FCC and the Obama Administration hope to accomplish this objective through incentive auctions, in which broadcasters can sell their spectrum licenses to bidders in an auction coordinated by the FCC. This proposal has been widely-endorsed,² though the FCC cannot conduct such an auction without additional authorizing legislation.

While the potential for incentive auctions to produce “new” spectrum has garnered considerable attention of late, some industry observers have proposed a different path. Specifically, some have suggested liberalizing broadcast licenses and allowing licensees to sell those licenses on a secondary market instead of through auctions.³ The FCC and others

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² Paul Milgrom, Gregory Rosston, and Andrzej Skrzypacz, "Letter from 112 Economists to President Obama Regarding Incentive Auctions", April 6, 2011. The authors are signatories to this letter.
³ See, for example, Jeffrey A. Eisenach, *Spectrum Reallocation and the National Broadband Plan* (Navigant Economics, LLC, October 2010).
have responded that coordination, hold-out, and related interference problems may make such an approach unworkable.⁴

This debate, however, obscures the key point, which is that policy must ensure that spectrum can be employed in its highest-valued use not only at a point in time, as assured by a well-designed auction, but also over time, as ensured by well-functioning secondary markets. The way to achieve that objective is not just to move spectrum to high-value uses as efficiently as possible—though that is extraordinarily important—but also to ensure that once employed in today’s high-value uses a market exists that creates the ability and incentive for licenses to be bought and sold as supply and demand conditions change.

The critical conclusion, then, is that incentive auctions (coordinated by the FCC) and private secondary markets for spectrum are best viewed as complementary rather than substitute mechanisms for promoting the seamless flow of spectrum from lower-valued to higher-valued uses now and over time. Successful incentive auctions would yield consumer benefits well in excess of any revenues raised by the auctions. But ensuring that the auctioned spectrum can then be bought and sold on secondary markets is also crucial for maximizing those benefits over time.⁵

**Secondary Markets in Perspective**

Secondary markets in general have received relatively little attention by economists or policymakers.⁶ Yet despite their quiet role secondary markets are vital to the United States economy. Secondary markets exist across a wide swath of goods sold in the United States. Secondary trades in goods ranging from housing to automobiles to virtually

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⁴ See, for example, Paul Milgrom, Gregory Rosston, and Andrzej Skrzypacz, “Letter from 112 Economists to President Obama Regarding Incentive Auctions,” April 6, 2011. Both authors of this paper are signatories to the letter.

⁵ The formal relationship between initial holders of spectrum rights (e.g., auction winners) and secondary markets is provided in Appendix A.

⁶ Broadly speaking, a secondary market is one in which a seller of a good is not the one who initially sold the good, though there is not always a bright line between transactions better described as wholesale and those better described as secondary. In the context of spectrum, a host of economic activities fall under this definition.
everything sold at garage sales and on platforms like eBay permit billions of dollars of goods each year to flow from lower-valued to higher valued uses.

The valuable role of secondary markets in promoting economic welfare may potentially be especially high in the case of spectrum. Secondary markets in general often involve trade in used goods, which are not typically perfect substitutes for new goods being sold in a primary market. Used cars are not perfect substitutes for new cars, and cars over a certain age or in particular states of disrepair may not even be in the same market as new cars. There is no such thing, however, as “used” spectrum, which, though finite and perishable, is constantly renewed. For any given frequency and geography, spectrum sold on secondary markets is equally valuable to spectrum auctioned by the government, holding constant features such as how it is aggregated or must be aggregated with other spectrum. Thus, if appropriately enabled, one “unit” of spectrum supplied through a secondary trade to a customer that places high value on spectrum is exactly equivalent to one “unit” of spectrum provided through an incentive auction.

Policy Progress in Secondary Spectrum Markets

For decades, licenses issued by the FCC for spectrum rights were sufficiently restrictive that many secondary market transactions were effectively denied. Beginning with the Clinton Administration, however, and continuing into the first part of the 21st century the FCC undertook a number of reforms to liberalize the potential for secondary market spectrum trading. A critical step that the FCC took, which was directly authorized by Congress, was to create the Commercial Mobile Radio Services (CMRS) in the mid-1990s. CMRS licensees were granted very broad use and technical flexibility, giving them property-like rights and facilitating their trading. Also in the mid-1990s, with its implementation of auctions, the FCC also reduced or eliminated many “anti-trafficking”

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7 Spectral and geographic aggregations may make spectrum more or less valuable to a given buyer depending on its needs. For example, on one hand a buyer wanting a nationwide license may bid more for it if the government has undertaken the effort to put that license together than it would if it had to buy the licenses piecemeal. On the other hand, some buyers may only want smaller licenses, making it possible that the spectrum is more valuable when it can be sold to different entities in different areas. Note that in the latter case if the sale price of the license in pieces exceeded the value of the license to the buyer of the nationwide license and secondary markets worked well, the buyer would turn around and sell the license in smaller pieces.
restrictions that prevented licensees from freely transferring spectrum. In the late 1990s, the FCC also adopted regulations that permitted CMRS licenses to “partition” their licenses geographically and “disaggregate” them spectrally, which permitted licensees the flexibility to acquire spectrum in blocks that were different than the initial license granted by the FCC. Also, the FCC has taken great strides in reducing the amount of time to approve license transfers, as indicated in Figure 1. Today, many secondary market trades may often be better characterized as “notification,” rather than “approval” by the agency.

Figure 1 - Days for FCC Approval of Secondary Market Transactions

![Time from Application Receipt to Approval](chart)

Source: Derived from ULS data.

The result, as seen in Table 1, has been the growth of secondary spectrum market trading. As we have recently documented elsewhere, secondary trades involving mobile virtual network operators (MVNOs), trades in the machine-to-machine (M2M) market and
direct secondary trades have all grown over the past decade.\textsuperscript{8} Measured in MHz-pops, or the bandwidth in megahertz times the population covered by the license, about 10 billion MHz-pops of spectrum have changed hands annually since 2003. To put that into perspective, the well-publicized 700 MHz auction in 2008 conducted by the FCC released about 18 billion MHz-pops into the market.

**TABLE 1**

<table>
<thead>
<tr>
<th>Year</th>
<th>PCS</th>
<th>Land Mobile Commercial</th>
<th>Broadband Radio</th>
<th>Microwave</th>
<th>Paging</th>
<th>Coast &amp; Ground</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>0.31</td>
<td>0.004</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.31</td>
</tr>
<tr>
<td>1998</td>
<td>3.05</td>
<td>0.013</td>
<td></td>
<td>10.58</td>
<td></td>
<td></td>
<td>13.64</td>
</tr>
<tr>
<td>1999</td>
<td>12.11</td>
<td>2.530</td>
<td></td>
<td>170.97</td>
<td></td>
<td></td>
<td>185.61</td>
</tr>
<tr>
<td>2000</td>
<td>13.44</td>
<td>0.716</td>
<td></td>
<td>9.04</td>
<td>0.004</td>
<td></td>
<td>23.19</td>
</tr>
<tr>
<td>2001</td>
<td>9.18</td>
<td>0.468</td>
<td></td>
<td>87.20</td>
<td>0.005</td>
<td></td>
<td>96.85</td>
</tr>
<tr>
<td>2002</td>
<td>5.39</td>
<td>0.354</td>
<td></td>
<td>57.00</td>
<td>0.012</td>
<td>0.014</td>
<td>582.77</td>
</tr>
<tr>
<td>2003</td>
<td>12.61</td>
<td>0.121</td>
<td></td>
<td>49.10</td>
<td>0.016</td>
<td>0.001</td>
<td>61.85</td>
</tr>
<tr>
<td>2004</td>
<td>14.58</td>
<td>0.188</td>
<td></td>
<td>14.67</td>
<td>0.056</td>
<td>0.015</td>
<td>29.51</td>
</tr>
<tr>
<td>2005</td>
<td>7.66</td>
<td>7.510</td>
<td></td>
<td>12.60</td>
<td>0.030</td>
<td>0.035</td>
<td>84.03</td>
</tr>
<tr>
<td>2006</td>
<td>8.92</td>
<td>1.100</td>
<td></td>
<td>13.00</td>
<td>0.052</td>
<td>0.093</td>
<td>144.19</td>
</tr>
<tr>
<td>2007</td>
<td>9.14</td>
<td>2.200</td>
<td></td>
<td>2.40</td>
<td>0.027</td>
<td>0.043</td>
<td>51.71</td>
</tr>
<tr>
<td>2008</td>
<td>12.58</td>
<td>0.326</td>
<td></td>
<td>18.699</td>
<td>0.009</td>
<td>0.087</td>
<td>41.75</td>
</tr>
<tr>
<td>2009</td>
<td>0.61</td>
<td>0.034</td>
<td></td>
<td>0.014</td>
<td>1.13</td>
<td>0.006</td>
<td>1.80</td>
</tr>
</tbody>
</table>

Source: Derived from ULS data

While some have pointed to the idiosyncrasies of spectrum as a challenge to the development and growth of secondary markets for spectrum, our review indicates that reforms enacted by the FCC in the past decade have significantly served to enable secondary trades.\textsuperscript{9} The development of secondary spectrum markets has, like other secondary markets, been quiet. And, like other secondary markets, it too has served to promote and advance economic welfare.


\textsuperscript{9} Ibid.
Conclusion: Next steps

Secondary markets are common throughout the economy, and secondary markets can play an important role in helping alleviate the growth strains that the burgeoning consumer demand for wireless telephony and broadband are creating. This is, however, not to say that policymakers can stand idly by and simply hope that secondary spectrum trading will blossom.

When property rights are defined clearly and information can flow freely these markets work well and are typically unremarkable. But property rights to spectrum have been more controversial, in part because license holders own the right to use spectrum but do not technically own the spectrum itself. In addition, those usage rights are often constrained by a wide range of restrictions, including time of use, geographic area, spectral frequency, technology allowed, and even the purpose for which the spectrum can be used. Though these factors, plus interference issues, can make defining property rights difficult, they do not make it impossible.

Additionally, secondary market growth appears to have been impeded by a general lack of information on who owns what spectrum and who might, and at what price, be prepared to part with that spectrum. In that regard, the good news is that the FCC keeps track of this information. The bad news is that the database, the Universal Licensing System (ULS) is extremely difficult to use and, if anything, is becoming more difficult due to the ability of license holders to disaggregate (divide into smaller frequency blocks) and partition (divided into smaller geographic areas) licenses. The opaqueness of this database may constitute one barrier to a more robust secondary spectrum market.

Another difficulty in evaluating how well the market for spectrum licenses themselves work is that it is not obvious what an efficient market should look like. Perhaps an efficient market would be one in which spectrum is traded on exchange platforms like stocks and commodities, and such a platform has not yet been successful because of issues related to spectrum supply. On the other hand, perhaps demand for naked spectrum—that is, just spectrum not bundled with network use—is not of a sort that could make sufficient use of spot markets to facilitate viable trading platforms.
Finally, spectrum is multi-dimensional. For instance, spectrum demanded by a customer is typically conditioned by requirements for a certain frequency (or frequencies), a specific geographical dimension and a well-specified temporal dimension. The supply of spectrum is likely to be equally conditioned. As noted by one economist, “spectrum isn't like pork bellies. Pork bellies are nice.” This multi-dimensional nature of spectrum creates the potential for a “thin” secondary market for spectrum.

In sum, the lesson from our analysis are straightforward – well functioning secondary markets for spectrum hold the promise to complement other policy efforts, such as incentive auctions, designed to facilitate the movement of spectrum from lower-valued to higher-valued uses for society. In this regard, policy design improvements directed toward secondary spectrum markets have proven successful over the past decade. This is not to say that challenges to further growth and secondary market efficiencies do not present themselves. Policy reflections on these remaining impediments to an even more robust secondary market for spectrum are important. What remains to be done and what an efficient market will look like are subjects of substantive debate that should happen. But secondary spectrum markets simply hold too much promise to put off the table at this moment when the economic benefits to freely flowing spectrum are so high.

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Appendix A: The Economic Relationship Between Initial and Secondary Spectrum Markets

The relationship between the market for auctioned spectrum and secondary spectrum markets can be seen in Figure 1. Assume that a fixed amount of spectrum $S_0$ is auctioned. Given a demand for spectrum $D_0$, the market clearing price is $P_0$. As a result of the auction, consumers that value spectrum more highly than $P_0$ will secure spectrum. Those consumers that value spectrum less highly than $P_0$, however, fail to get the spectrum they desire. The result is that, upon completion of the auction, a residual demand is created that consists of the lower portion of the demand curve $D_0$ (the portion below $P_0$).

We assume here that the auction for spectrum is efficient in the sense that those who value spectrum the most highly are winners of the initial auction. Were the initial auction to be inefficient, then the presence of secondary markets could help rectify the initially inefficient allocation of spectrum resources. See Gupta, M. and B. Lebrun, “First Price Auctions with Resale,” *Economic Letters* 64 (1999) 181–185.
In a dynamic market such as spectrum the passage of time will result in changes to the demand for spectrum by both the winners of the initial auction and the initial auction losers. Consider the case of a subsequent reduction in the demand for spectrum by the initial auction winners. This is depicted in Panel A. Demand reductions by the initial spectrum auction winners is depicted by a shift inward of their demand to $D_1$. In the absence of transaction costs this creates the opportunity for the initial auction winners to gain value by selling spectrum to auction losers that now more highly value the spectrum than the initial auction winners. The opportunity for the spectrum holders to enhance value is given by the mirror image of the demand curve $D_1$. That is, if we consider $S_0$ to constitute the new ordinate in a diagram of a secondary spectrum market on the right hand side of Panel A, the supply function is given by $S_1 = S_0 - D_1$. Given the supply to the secondary market, and the residual demand from the initial auction losers, the secondary spectrum market will clear at a price $P_1$. Importantly in this case, the presence of the secondary spectrum market creates the opportunity for the creation of enhanced economic welfare than a simple auction with no resale. Both consumer and producer surplus are enhanced in this case.

In Panel B, we consider the case in which, after the initial auction is conducted, the demand for spectrum rights increases for initial auction losers. This, of course, also includes firms that may not have bid in the initial auction. In this case, the opportunity again arises for value creation by the presence of a resale market. In particular, there now exists parties without spectrum that value the spectrum held by initial auction winners more highly than the spectrum holders. In this case, we can again reorient the ordinate of the graph to be $S_0$, in which case the supply function by the initial spectrum holders into a secondary spectrum market is given by $S_1$. This supply function is again determined residually; in this case as the difference between $S_0$ and the value of $D_0$ on the left hand side of Panel B. Given this supply into the secondary market, the equilibrium price in the secondary market is $P_1$. Once again, both consumer and producer surplus are enhanced by the presence of the secondary market.

There are, of course, several potentially complicating considerations. These include: (1) a consideration of the option value of spectrum held by initial holders of spectrum
rights as they consider whether to sell into a secondary market; (2) the option value of parties in the initial spectrum auction as they consider the potential to gain desired spectrum in secondary market transactions; and (3) the possibility of “hold out” in secondary markets by incumbents who fear that new spectrum holders will drive prices for spectrum-enabled goods and services down.

Consider the implications of a resale market for (1) and (2). The opportunity for an initial bidder to resell part or all of its inventory of spectrum creates the potential to reclaim part of the value committed in the initial auction in the event that subsequent demands are less robust than expected. This “resale sellers’ effect” has the effect of enhancing the willingness of initial auction bidders to pay for spectrum rights.12 Thus, the option and fluidity with which buyers can subsequently resell their spectrum should translate into higher prices in initial auction sales. Potential purchasers of spectrum rights in initial auctions will also be affected by the presence of secondary markets as a well-functioning resale market may afford the purchaser to defer its initial purchase. This “resale buyers’ effect” may reduce the demand for in an initial spectrum auction, leading to reduced initial auction valuation.13 This effect, however, is itself affected by the nature of the anticipated competition for spectrum in the initial auction. If prospective players in the initial auction anticipate that robust demand at the initial auction to translate into robust demand for residual spectrum rights in secondary markets, then anticipated high secondary market prices will push firms to participate in the initial auction, both for fear of high secondary market prices and for the opportunity to reclaim value in a robust secondary market. While the quantitative impact of these effects has not been empirically determined in the case of spectrum markets, the presence of robust secondary markets in other industries has been found to positively affect initial auction prices, affirming the essentially complementary nature of the relationship between initial and secondary markets.14

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13 Ibid.
14 Ibid.
Finally, the incentives for “hold out” by initial spectrum rights holders has the potential to affect both initial and secondary spectrum markets. Of particular concern is the potential for “hold out” to raise prices in secondary markets to prospective entrants who then face higher costs than incumbents. Such “raising rivals’ costs” strategies have been the ire of antitrust economists and policymakers.\textsuperscript{15} Claims of “hold out” entail one of two scenarios. First, “hold out” may become a problem if the holders of initial spectrum rights conspire to withhold spectrum from secondary markets. While such collusion would potentially have grave economic consequences, existing antitrust law establishes this behavior as a felony offense with severe monetary penalties and prison sentences to those convicted. Second, an individual holder of spectrum rights may unilaterally decide to withhold spectrum from secondary markets. Depending on the market structure, rivalries and composition of those holding initial spectrum rights, it is possible that a single firm might unilaterally act to withhold spectrum from secondary markets thereby raising prices in a secondary spectrum market. To the extent that such behavior is part of an attempt to monopolize downstream markets that are dependent on spectrum, such activities are again within the domain of antitrust enforcement officials. Thus, while hold out strategies tend to capture attention, with proper antitrust enforcement, they are not likely to lead to tangible distortions in secondary spectrum markets.