WHAT REALLY MATTERS IN SPECTRUM ALLOCATION DESIGN

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What Really Matters in Spectrum Allocation Design

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Wireless license auctions have successfully replaced "beauty contests" in many countries. Competitive bidding (1) puts spectrum rights in the hands of the most productive firms; (2) reduces rent-seeking costs; and (3) captures license values for the public, potentially reducing costly tax distortions. Economists and policy makers have asymmetrically focused on (3). Yet, the overwhelming consumer welfare gains are produced in output (retail services) markets, not by extracting revenues from the sale of spectrum inputs. This fact leads to powerful policy implications, supporting liberal policies that permit market rivals to (quickly) access abundant bandwidth.

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I. Introduction

Economists and policy makers have embraced "spectrum auctions."[1] Assigning wireless licenses to high bidders places assets with the most productive firms, reduces rent-seeking costs incurred by comparative hearings or lotteries,[2] and captures license rents for the public treasury. This last benefit potentially increases efficiency in that funds generated without the use of taxes do not cause tax-distorting social losses. Each tax dollar raised, for instance, is expected to cost society about $0.33 in deadweight loss.[3] Auction dollars, as pure transfers, cost less.

Yet this "public finance bonus" is a delicate matter. Government allocates spectrum and regulation constrains its use. Wireless licenses generate bids approximately equal (in a competitive auction) to the present value of the profits expected from owning such licenses. Policies that increase profits by reducing competition in wireless markets are themselves economically distorting. Revenues gained by the state cease to be pure transfers and incur social costs of their own.

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[1] "Overall, the auctions have been a tremendous success . . . . Many countries wisely have imitated the FCC auctions; those that have not have suffered from inefficient license assignments and other flaws." Peter Cramton, *Spectrum Auctions*, *in* 1 HANDBOOK OF TELECOMMUNICATIONS ECONOMICS 605 (Martin E. Cave et al. eds., 2002); *see also* Ken Binmore & Paul Klemperer, *The Biggest Auction Ever: The Sale of the British 3G Telecom Licenses*, 112 ECON. J. C74 (2002); Peter Cramton, *Money Out of Thin Air: The Nationwide Narrowband PCS Auction*, 4 J. ECON. & MGMT. STRATEGY 267 (1995); Paul Klemperer, *How (Not) to Run Auctions: The European 3G Telecom Auctions*, 46 EUR. ECON. REV. 829 (2002) [hereinafter Klemperer, *How (Not) to Run Auctions*]; Paul Klemperer, *What Really Matters in Auction Design*, 16 J. ECON. PERSP. 169 (2002); R. Preston McAfee & John McMillan, *Analyzing the Airwaves Auction*, 10 J. ECON. PERSP. 159 (1996); John McMillan, *Selling Spectrum Rights*, 8 J. ECON. PERSP. 145 (1994); Patrick S. Moreton & Pablo T. Spiller, *What's in the Air: Interlicense Synergies in the Federal Communications Commission's Broadband Personal Communication Service Spectrum Auctions*, 41 J.L. & ECON. 677 (1998); Eric van Damme, *The Dutch UMTS-Auction* (Ctr. for Econ. Studies & Ifo Inst. for Econ. Research, Working Paper No. 722, 2002); Elmar Wolfstetter et al., *Low Price Equilibrium in Multi-unit Auctions: The GSM Spectrum Auction in Germany* (Ctr. for Econ. Studies & Ifo Inst. for Econ. Research, Working Paper No. 506, 2001); Elmar Wolfstetter, *The Swiss UMTS Spectrum Auction Flop: Bad Luck or Bad Design?* 6 (Ctr. for Econ. Studies & Ifo Inst. for Econ. Research, Working Paper No. 534, 2001) [hereinafter Wolfstetter, *The Swiss UMTS Spectrum Auction Flop*].

[2] Thomas W. Hazlett & Robert J. Michaels, *The Cost of Rent-Seeking: Evidence from Cellular Telephone License Lotteries*, 59 SE. ECON. J. 425 (1993).

[3] Klemperer, *What Really Matters in Auction Design*, *supra* note 1, at 179.

Many are aware of this conflict and emphasize the importance of rules that promote competition for end users. John McMillan, in one of the first scholarly papers explaining the new wireless license auctions, was careful to note:

> The Act [enabling auctions] downplays revenue as an objective, and by its actions also the government showed that revenue was not its overriding objective (as, indeed, it should not be). If revenue had been paramount, the government could have offered a single monopoly license in each region—at the cost, obviously, of creating future inefficiencies.[4]

Yet this important caveat has been only partly heeded. The formal economic literature on wireless auctions focuses not on end-user efficiencies, but on bidding mechanisms. Empirical evaluations are largely rendered on the basis of rent extraction. Auctions resulting in prices exceeding expectations are deemed "successful"; those with surprisingly low prices are "fiascoes" or "disasters." License rents left on the table create social inefficiency, sacrificing a possible public financing bonus.

Were auction policies simply transferring rents for the public treasury, this operative assumption would reflect reality. Yet, rules advanced by economists and widely adopted by policy makers repeatedly cross over the presumed line of demarcation, altering efficiency in output markets. Imposing reserve prices, limiting the number of licenses sold, providing bidding credits for weak competitors, and delaying license assignments are regulatory policies advanced in response to the "low participation" problem encountered at auctions. Economists largely evaluate these measures according to their effectiveness in raising bids, ignoring retail market consequences.

Case studies reviewed in the literature illustrate the inconsistent incorporation of final market welfare effects. Klemperer discusses an interesting Turkish mobile phone license

[4] McMillan, *Selling Spectrum Rights*, *supra* note 1, at 147.

auction, wherein the government mandated that the price for a second national license would equal or exceed that bid by the winner of the first license.[5] That prompted the first licensee to bid aggressively, such that a second operator would not pay the steep entry fee; the result was monopoly market structure. Klemperer identifies this as "the Turkish fiasco."[6]

Alternatively, reserve prices set in Belgium and Greece auctions were applauded for extracting additional government receipts, even though they excluded award of a fourth 3G license in 2001 auctions (only three incumbents' bids met the threshold; i.e., the policy was defended on the grounds that no fourth network would have likely emerged even with a lower reserve price). Of course, with the probability above zero, the expected loss merits consideration. Moreover, even without the entry of a fourth operator, the policy left considerable bandwidth idle (as per the approximately 35 MHz allocated to the marginal licenses in either market). This impedes reductions in incumbents' marginal costs, imposing social losses. Such offsets to the revenue-generating gains of the reserve price have not been appropriately incorporated.

As this Article shows, the reserve price policy in the two countries likely resulted in large losses for Belgian and Greek consumers that overwhelmed any possible gains from the public finance bonus. This empirical result, based on the relationship between spectrum inputs and competitive rivalry in retail mobile telephone markets, quantifies the importance of addressing welfare issues in wireless markets in a holistic fashion that looks beyond government revenues. Efficiencies generated by license auctions are evaluated in proper context when auction designs, bidder subsidies, license restrictions, and other policies are evaluated with the response to their

[5] Klemperer, *What Really Matters in Auction Design*, *supra* note 1, at 176.

[6] The Turkish government agreed, and undid the monopoly outcome via new rules.

incremental auction revenues and to the social costs incurred when radio frequencies are less-utilized, inefficient suppliers win licenses, or multi-year delays reduce entry.

Many regulators have come to the conclusion—correctly, in this Article's view—that burgeoning use of smartphones, tablets, and other devices (including "machine-to-machine" (M2M) radios) is driving a "mobile data tsunami" that demands massive new bandwidth. Great productivity is feeding this beast, expanding networks, improving speeds, and accommodating a range of innovative services and applications. The Federal Communications Commission's (FCC's) National Broadband Plan issued in March 2010 specifically focuses on the importance of making additional spectrum available for mobile uses. It identifies wireless broadband as a key contributor to U.S. economic growth and an essential platform for the emerging broadband marketplace. Crucially, more inputs are necessary to "ensure that there is sufficient, flexible spectrum that accommodates growing demand and evolving technologies."[7]

This is exactly correct. To maximize consumer welfare, spectrum allocators should avoid being distracted by side issues like government license revenues. By focusing on wireless market efficiency, getting abundant spectrum resources into a competitive marketplace, policy makers can pave the way for low prices, high outputs, and robust innovation. The economic forces unleashed will produce the highest social gains.

Part II offers a simple synopsis of this Article's analysis using "order of magnitude" estimates revealing the big picture—consumer gains in wireless output markets dominate social welfare generated by government extractions for spectrum inputs. Part III then describes the emphasis placed on revenue extraction by economists, noting the inconsistent manner in which efficiency changes in output markets sometimes enter the analysis. Part IV more specifically

[7] FED. COMMC'NS COMM'N, CONNECTING AMERICA: THE NATIONAL BROADBAND PLAN 75 (2010).

evaluates the argument that spectrum policy makers should tolerate some inefficiency in wireless markets to produce social gains in public finance. It finds this argument to be implausible given the institutions of the market and the magnitudes of the relevant trade-offs. Part V defines a "regulatory optimum." Part VI offers a conclusion.

II. License Auctions: Trees in the Wireless Forest

Economic research has quantified the incremental trade-offs incurred in particular spectrum allocation choices, as detailed below. The big picture, however, is perhaps best illuminated by simple summary statistics.

In the first half of 2009 (1H2009), total U.S. mobile telephone service revenues were approximately $75.8 billion.[8] Of this, $56.3 billion was for basic subscriptions that include voice service.[9] The remaining $19.5 billion was for data services, primarily text (SMS) messages and high-speed Internet connectivity (web access).[10] Industry sources report 1.16 trillion minutes of use (MOU) for voice services, and 740 billion text messages.[11] If the voice revenues (total revenues minus data revenues) are divided by voice minutes, the average price per minute is calculated to be $0.049. If text messages are included in total MOU[12] at the rate of 1 SMS = 1 minute, and total revenues are attributed entirely to voice and text message services, then the average price per MOU (or text message) would be $0.040. This overstates price by attributing

[8] Targeted Information, Cellular Telecomms. & Internet Ass'n, Mid-Year Data Survey Results 1 (Oct. 7, 2009) (on file with author).

[9] *Id.* (subtracting the revenues for data services from total revenues).

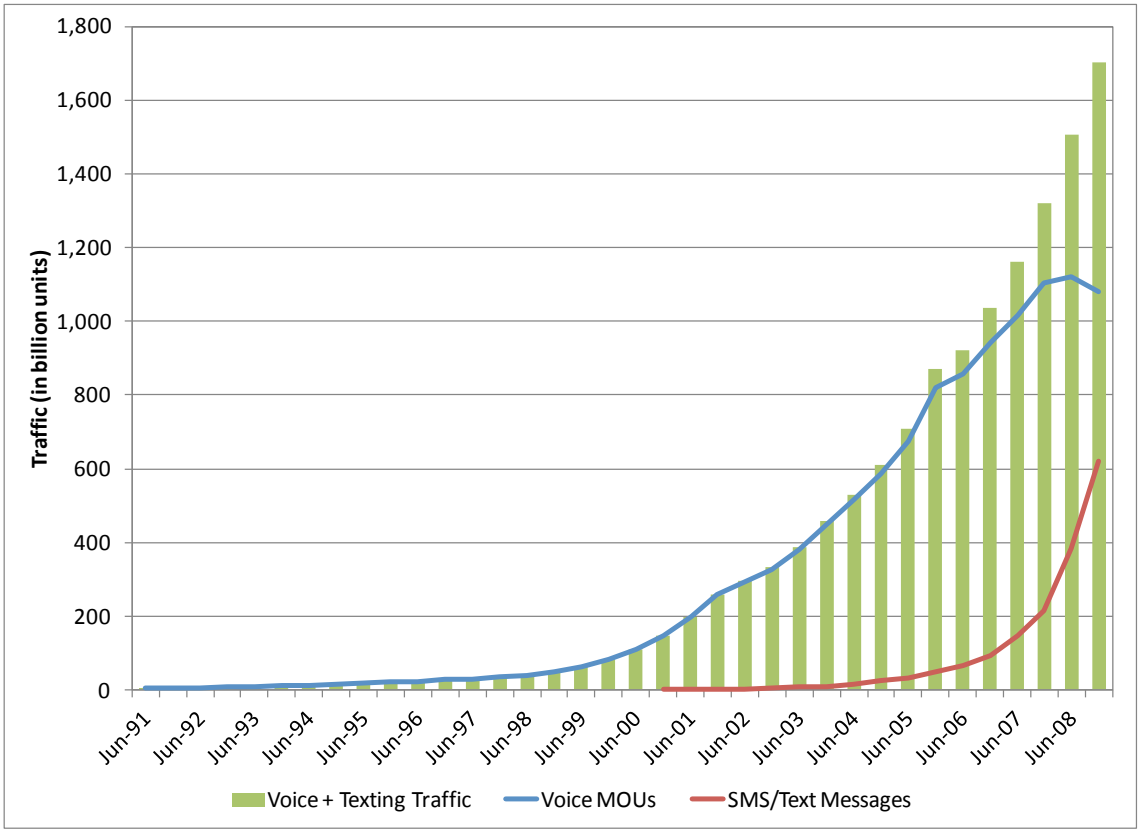
[10] *Id*. at 2.

[11] *Id.*

[12] Including text messages in the voice minutes total is suggested by the fact that SMS is a substitute for voice calls and pricing structures in the industry imply that looking at voice minutes and revenues separately may distort actual economic outcomes. Of course, using an improper conversion (to add text messages to voice minutes) may also distort the true picture. Setting text messages equal to one MOU in terms of value appears a reasonable starting point.

high-speed data charges to voice and text, when they properly belong to a third category. In 2008, messaging (both text and multi-media) accounted for some thirty-six percent of wireless data revenues.[13] Using this metric for the first half of 2009 yields an average price per MOU (counting 1 SMS = 1 MOU) of $0.033.

FIG. 1. VOICE MINUTES AND TEXT MESSAGES IN U.S. MOBILE NETWORKS (1991–2008)



Market data from 1991 forward are available,[14] showing revenues and MOU for the U.S. mobile market. Until recently, complications presented by the voice-data divisions were not an

[13] Total wireless data revenues were reported to be $17.5 billion in the second half of 2008, while text messaging revenues (broken out from total data revenue) were $6.3 billion. CELLULAR TELECOMMS. & INTERNET ASS'N, CTIA'S WIRELESS INDUSTRY INDICES: SEMI-ANNUAL DATA SURVEY RESULTS, YEAR-END 2008 RESULTS, 112, 114 (2009) [hereinafter CTIA YEAR-END 2008].

[14] These data are published semi-annually by the Cellular Telecommunications and Internet Association (CTIA), a trade group composed of U.S. wireless carriers. *Id.*

issue. There is now, however, a pronounced trend where mobile subscribers are substituting text messaging for voice minutes.[15]

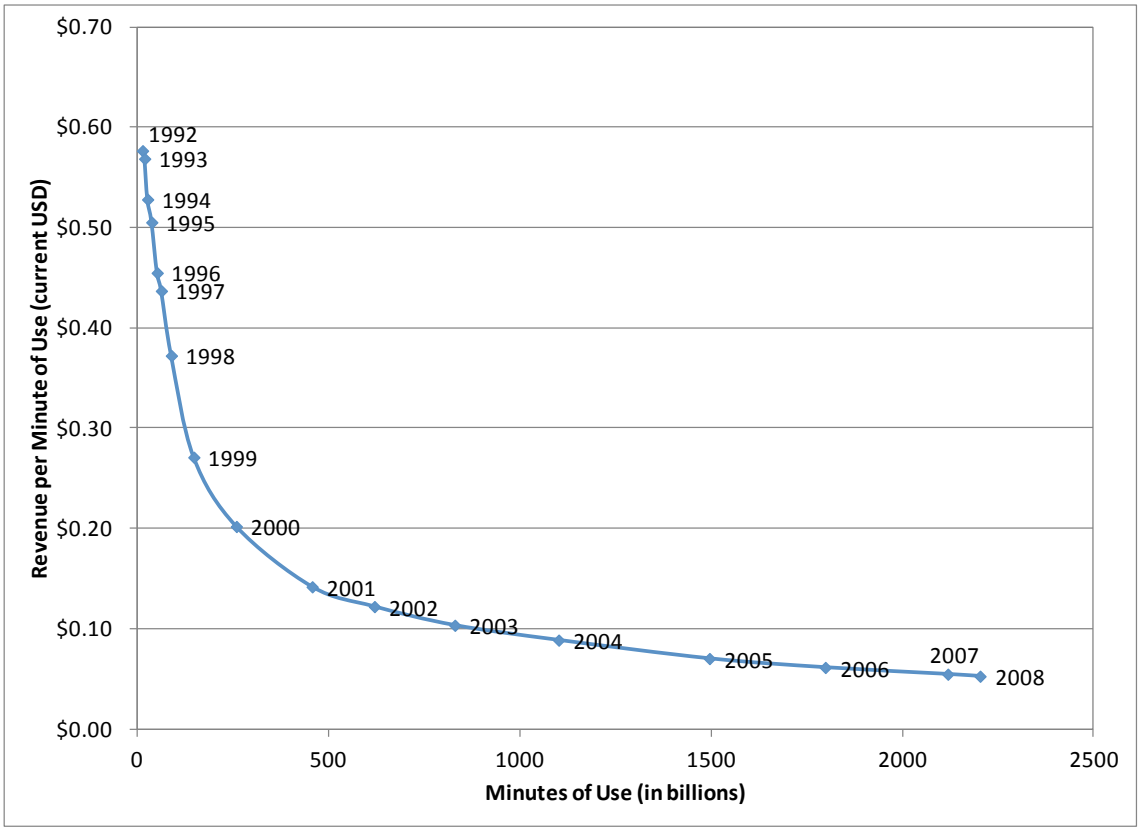
We make simple adjustments to the data to smooth the long-run trend and to account for the emergence of texting in place of phone calling. CTIA revenues from 2001 to present are broken out as "voice" or "data." Text message revenues and quantities (text messages) are also reported. Hence, on the service revenue side, data expenditures are subtracted from total service revenues and text message revenues are then added back in. (This excludes revenues for other data services, primarily high-speed Internet access.) On the usage side, text messages are added to voice minutes of use at a rate of 1 SMS = 1 MOU.

Figure 2 displays historic prices and outputs. Price is defined as the average revenue (all spending for services by consumers) divided by the number of minutes used. Quantity is defined as the total MOU. The trend in prices is sharply down, and the trend in output is strongly up.

These data appear to assume the shape of a demand curve showing a negative relationship between price and quantity demanded. This is not the case, however. Along a given demand curve, the only variable influencing output is the price of the product. Factors such as supply, quality of service, the price of substitutes, and the availability of complements or substitutes change over time, and much time elapses between the points along the curve in Figure 2—as much as sixteen years.

[15] *See infra* Figure 1.

FIG. 2. PRICES AND MOBILE VOICE MINUTES OF USE, 1992–2008



Still, the important mobile market demand drivers (apart from the price of wireless service) are all predicted to influence demand in a positive direction.[16] In the 1991–2009 period, service prices fell dramatically, from over $0.50 per MOU to about $0.04, a real decline of over ninety percent.[17] This would be expected to lead to substantial increases in minutes demanded. Indeed, consumption virtually exploded: increasing from 11 billion MOU in 1991 to about 2.3 trillion MOU (excluding text messages) in 2009—a *208-fold* (20,800%) increase. It is likely that

[16] It is also helpful that in an industry with substantial fixed costs, such as mobile telephony, there exists no traditional supply curve. Marginal cost does not determine the quantity offered by firms, and mark-ups over marginal cost are subject to strategic and long-run dynamics not easily captured in two dimensions. In wireless markets it is also the case that capacity available for consumers has been shifting out (increasing) over time, but the impact of this supply effect is captured in (a) lower prices, (b) higher quality service (fewer blocked or dropped calls).

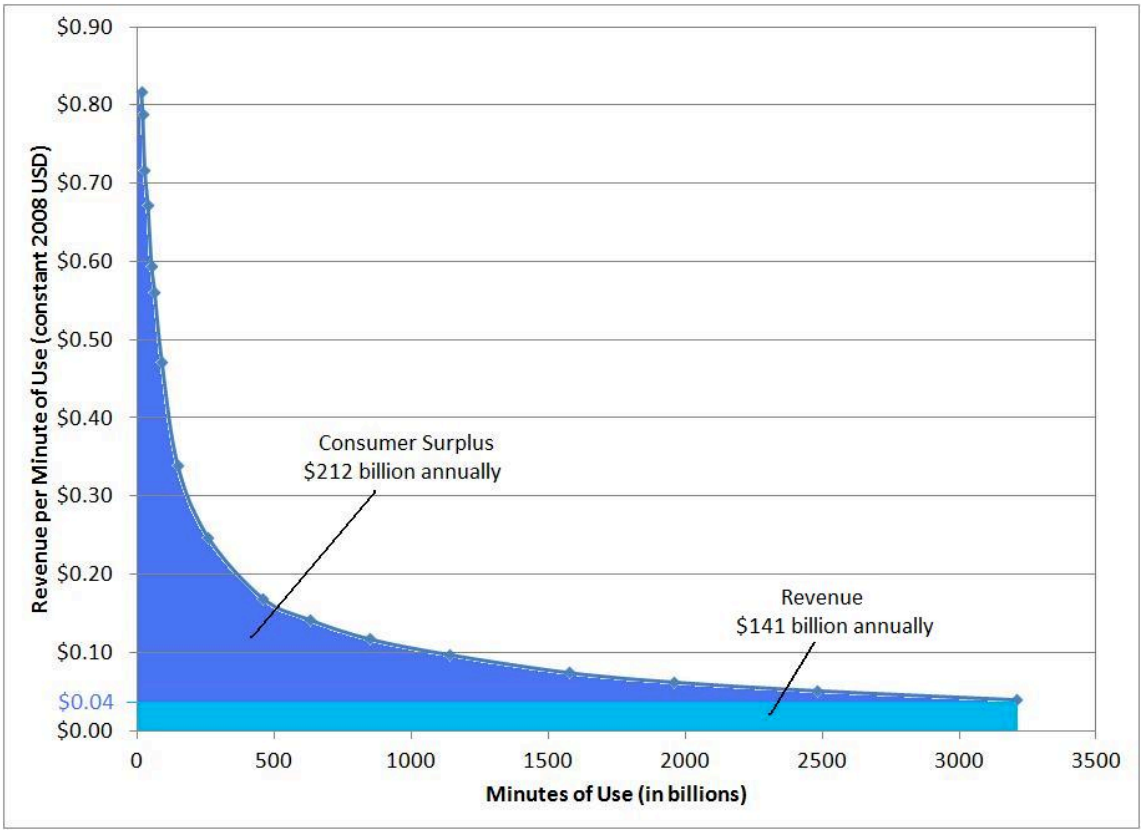
[17] Prices are in current dollars. In constant 2008 dollars, differences are more than 40% larger (due to inflation). Constant 2008 dollars were obtained using the GDP deflator series from the International Monetary Fund's World Economic Outlook 2011.

price was one of many factors encouraging this robust output trend. Demand shifted outwards with rising income, increasing quality of wireless services, broader network coverage, the declining size and price of handsets, the increasing quality and functionality of handsets and batteries, the introduction of popular mobile applications, and changing social norms regarding the use of mobile phones and network connectivity.

Circumstances here allow us to view the historic price-quantity pairs as lower-bound estimates of current conditions with respect to consumer demand. Were higher prices charged today, quantities demanded would contract, but not, presumably, to less than the usage levels observed in previous years when higher prices were, in fact, observed. In essence, the market data from 1991 through 2008 yield information as to the lower bound of the 2009 demand curve, allowing conservative forecasts of the value currently delivered by wireless network services in the United States.

The basic calculation is displayed in Figure 3. Consumer surplus (CS) is the incremental value obtained by customers in a particular market. It is formally defined as what consumers are willing to pay for a good or service minus what they must pay to obtain the product. The area under the "quasi-demand curve" is calculated as a discrete integral, summing each of the incremental CS values associated with a historic price/quantity point (annualized), as prices monotonically fall over time. This method produces slightly lower estimates than taking a continuous integral (for example, using a close-fitting, fourth-order equation). Prices are all in constant 2008 dollars as adjusted by the GDP deflator series from the International Monetary Fund's World Economic Outlook 2011.

FIG. 3. QUASI-DEMAND CURVE FOR VOICE/TEXT MOBILE SERVICE (2008)



Focusing only on voice revenues—Model 1—deduces a 2008 price (equal to average voice revenue per voice MOU) of 0.0526, and about 2.2 trillion MOU for the year. Consumer surplus, estimated conservatively as described above, is then forecast as $174.1 billion annually (constant 2008 dollars).[18] Alternatively, by adding text messages to voice MOU (at 1 SMS = 1 MOU)—Model 2—the substitution from phone calls to text messages in recent years is plausibly

[18] This is somewhat above the level of 2008 revenues, indicating a (CS-to-revenue) ratio that is in line with econometric estimates of consumer surplus in mobile markets. *See* Jerry Hausman, Cellular, 3G, Broadband and WiFi, Shann Memorial Lecture at the University of Western Australia (Mar. 18, 2003). It is below the 2010 consumer surplus estimate produced for the Cellular Telecommunications & Internet Association, the U.S. mobile operators' trade group by consulting firm Ovum which estimated 2010 consumer surplus to be $263 billion. ROGER ENTNER, CELLULAR TELECOMMS. & INTERNET ASS'N, THE INCREASINGLY IMPORTANT IMPACT OF WIRELESS BROADBAND TECHNOLOGY AND SERVICES ON THE U.S. ECONOMY: A FOLLOW UP TO THE 2005 OVUM REPORT ON THE IMPACT OF THE US WIRELESS TELECOM INDUSTRY ON THE US ECONOMY 19 (2008).

incorporated. Revenue per MOU falls to $0.0396, with 2008 [MOU + text messages] rising to 3.2 trillion.[19] Consumer surplus is then calculated at $211.8 billion (2008 dollars).[20]

TABLE 1. ORDER-OF-MAGNITUDE COMPARISON:
AUCTION RECEIPTS VERSUS WIRELESS SERVICE VALUE

Metric	Period	Value	MHz	$/MHz/pop
U.S. Wireless Service Revenues	2009 (annual) (1H2009 x 2)	$151.7 billion	200	2.53
U.S. Wireless Service Revenues – Voice & Text	2009 (annual) (1H2009 x 2)	$127.1 billion	200	2.12
Consumer Surplus – Model 1	2009 (annual)	$174.1 billion	200	2.90
Consumer Surplus – Model 2	2009 (annual)	$211.8 billion	200	3.53
FCC Auction Revenues	1994–2009 (lump sum)	$53 billion	>280	< 0.63 (CMRS)

These value magnitudes are important to consider in light of the revenues received by the U.S. government for wireless licenses. Since license auctions began in July 1994, the FCC has collected about $53 billion,[21] a sum that includes many (mostly) non-cellular licenses. The major mobile license (what the FCC generically calls Commercial Mobile Radio Service, or CMRS, licenses) sales have been for personal communications services (PCS) licenses A–F, allocated 120 MHz; advanced wireless services (AWS) licenses A–F, allocated 90 MHz; and 700 MHz licenses allocated 70 MHz.[22]

Mobile licenses allocated some 230 MHz (nationwide) have been sold via FCC auctions through 2008. All told, however, licenses assigned to mobile operators were allocated about 345

[19] In fact, SMS revenues in 2008 were approximately $12 billion, or about ten percent of voice revenues. Basic calling plans must generally be purchased by customers before they can purchase text messages, which are usually bought in packages—200 for $5 per month, unlimited texting for $20, etc. CTIA YEAR-END 2008, *supra* note 13, at 114.

[20] *See infra* Table 1.

[21] FED. COMMC'NS COMM'N, MOVING FORWARD: DRIVING INVESTMENT AND INNOVATION WHILE PROTECTING CONSUMERS (2009) [hereinafter MOVING FORWARD], *available at* http://www.fcc.gov/fcc-moving-forward-report.pdf.

[22] These were awarded in auctions held 2002–2008; license letters were re-used during that process. In addition to these licenses, other bandwidth can potentially be used to compete with CMRS operators, including those allocated 2.5 GHz frequencies for use in Broadband Radio Services (BRS) or Educational Broadband Services (EBS); GWS (General Wireless Services) allocated 2.3 GHz spectrum; a license allocated 5 Hz at 1.605 GHz; and satellite telephone licenses permitted to supply terrestrial mobile phone services on an ancillary basis to their main satellite operations.

MHz. Only about 200 MHz of this total was actually in use at year-end 2008.[23] The 90 MHz allocated to AWS licenses, and assigned by auction in September 2006, was still being "cleared" of federal users and was largely off-limits for private operators.[24] Of the 700 MHz spectrum, only the 6 MHz use by Qualcomm's MediaFlo (a mobile TV application marketed through mobile phone carriers) had been deployed; the other 64 MHz was held by carriers planning to use the frequencies for advanced systems being developed.[25]

[23] RYSAVY RESEARCH, MOBILE BROADBAND SPECTRUM DEMAND (2008).

[24] Kathleen O'Brien Ham & Eric Hagerson, Comments of T-Mobile USA, Inc., *In re* Relocation of Federal Systems in the 1710–1755 MHz Frequency Band: Review of the Initial Implementation of the Commercial Spectrum Enhancement Act, Nat'l Telecomms. & Info. Admin., Docket No. 0906231085-91085-01 (Aug. 21, 2009).

[25] *See infra* Table 2. So-called 4G (fourth generation) mobile wireless systems are planned deployments by AT&T and Verizon, the firms that own these licenses. They have announced that they will start deploying LTE (long-term evolution) networks beginning in 2H2010. Christopher M. Larsen, *Telecommunications Services: Comments By Verizon CTO Indicate Limited Upside To Tower Revs For LTE in '10*, PIPER JAFFRAY (2010).

TABLE 2. MOBILE (CMRS) LICENSES AUCTIONED AND IN USE (YEAR-END 2008)

License Sale	Date	Total Revenue (billions)	Nationwide MHz	$/MHz/pop	Implied Value of 200 MHz Nationwide
PCS A, B	March 1995	7.721	60	$0.51	$30.6 billion
PCS C, D, E, F	Dec. 1995–Feb. 2005	not applicable	60	not applicable	not applicable
Nextel @ 1.9 GHz	2004	4.800	10	$1.70	$102.0 billion
PCS Re-auction	Feb. 2005	2.043	not applicable	$0.98	$58.8 billion
AWS	Sept. 06	13.700	90	$0.54	$32.4 billion
700 MHz - lower	2002–2003		18	$0.03	$1.8 billion
700 MHz - upper	Mar. 2008	18.957	52	$1.20	$72.0 billion
Total			**230**		
Mean (excluding lower 700 MHz)					**$59.2 billion**
Total CMRS MHz deployed[26]			194		

The wireless services supplied using approximately just 200 MHz allocated to mobile phone licenses enabled substantial economic activity. As summarized by the revenue and consumer surplus estimates, the magnitudes dominate license revenues. Even without adjusting for the fact that license revenues are primarily transfers rather than newly created wealth (with the public finance bonus about 0.33), services produce consumer gains of at least $2.90 or $3.50 per MHz per person *per year*. In contrast, license revenues are, at the most (i.e., attributing all federal auction receipts to the 200 MHz in use, when far more than that has been allocated to the

[26] RYSAVY RESEARCH, *supra* note 23, at 23, Bazelon breaks out the then- (or soon-) available bandwidth for mobile operators as: 50 MHz cellular (800 MHz band), 120 MHz PCS (1.9 GHz band), 29 MHz SMR (800/900/1900 MHz bands). This totals 199 MHz. Bazelon also notes availability of 174 MHz (at 2.5 GHz) for wireless services. Coleman Bazelon, Brattle Grp., *Licensed or Unlicensed: The Economic Considerations in Incremental Spectrum Allocations*, 47 IEEE COMMC'N MAG. 110, 112 tbl.1 (2009); *see also* Thomas Hazlett, *Spectrum Tragedies*, 22 YALE J. ON REG. 242 (2005). These frequencies, allocated from the early 1960s to licenses assigned for such services as educational video, have been the subject of numerous fragmentation problems as per the regulatory definition of usage rights. Clearwire, a firm receiving investments and/or partnership agreements from Sprint, Intel, Google, Motorola, Comcast and Time Warner, in addition to equity investments from its 2008 IPO, has aggregated many of the licenses and is attempting to build a nationwide wireless broadband network deploying advanced 4G "Wimax" technology. In the third quarter of 2009, it reported 555,000 U.S. customers. Press Release, Clearwire, Clearwire Reports Third Quarter 2009 Results (Nov. 10, 2009), http://corporate.clearwire.com/releasedetail.cfm?ReleaseID=551159. If the 2.5 GHz frequencies were to host viable competitive entry into the mass market for mobile services, this would have a profound impact on the competitive structure of the industry. Given the uncertain nature of this competitive foray, and the difficulty in assessing the scope and value of the bandwidth rights available to operators, the 2.5 GHz spectrum is generally excluded from totals given for the bandwidth available to mobile carriers (as in the 200 MHz estimate for year-end 2008).

licenses sold through 2008), about $0.63 per MHz per person as a *one-time* payment to the government.[27]

The implication is that the yearly gains from using spectrum for consumers (and ignoring profits generated by producers, another source of social benefit) appear to be at least four times the lump sum payments made for licenses. If a real discount rate of five percent is appropriate,[28] then perpetual annual flows are transformed into present values at a rate of twenty-to-one. This implies that the annual consumer benefits delivered by mobile markets is at least eighty times the magnitude of the receipts captured by FCC license auctions. An apples-to-apples comparison of efficiency gains would then imply that the license revenues must be reduced by two-thirds to reflect the social savings (not merely the transfers) implied by auction receipts. This implies that the efficiencies associated with retail services in mobile markets are about *240 times as large* as those associated with license revenues.[29]

This more than two order of magnitude difference puts spectrum allocation policy into sharp focus. Delicate adjustments that seek to juice auction receipts but also alter competitive forces in wireless operating markets are inherently risky. A policy that has an enormous impact in increasing license revenues need impose only tiny proportional costs in output markets to undermine its social utility. So, for example, a new auction design that (heroically) doubled

[27] Licenses sold at auction are issued for fixed terms, but are renewed indefinitely so long as the licensee complies with perfunctory rules. In effect, licenses are assigned permanently for a lump sum payment.

[28] A five percent real rate is generally appropriate for discounting future flows in cost-benefit calculations. Robert W. Hahn, *Economic Analysis of Regulation: A Response to the Critics*, 71 U. CHI. L. REV. 1021 (2004), at 1026–27. The lower the rate, the higher the present value of the annual consumer surplus flows.

[29] Other economists have found that consumer surplus is similarly one or two orders of magnitude the size of producers' surplus in wireless markets. *See generally* ENTNER, *supra* note 18; Hausman, *supra* note 18; Jerry A. Hausman et al., *Valuing the Effect of Regulation on New Services in Telecommunications*, BROOKINGS INSTITUTION (1997); Gregory L. Rosston, *The Long and Winding Road: The FCC Paves the Path with Good Intentions*, 27 TELECOMM. POL'Y 501 (2003).

auction revenues would, if it reduced consumer surplus by just one-half of one percent, produce costs in excess of benefits.

Policy makers and economists have devoted considerable energy to designing and then redesigning spectrum allocation rules and license auction platforms. They have often looked to sales of licenses at high prices as "successes" and sales at low prices as "fiascoes." Economists have justified this enthusiasm for revenue on efficiency grounds: The more money transferred to the government in auctions, the less money the government must raise via taxes. Taxes of the usual sort are highly distortive; firms and individuals engage in costly activity just to avoid paying them. The rule of thumb is that a dollar of taxes raised by the state results in about one-third of a dollar in distortion costs (in addition to the dollar transferred to the public treasury[30]). By raising a dollar in a license sale, then, one-third of a dollar is saved—under the assumption that government spending remains fixed (does not increase with the spectrum revenue windfall). Such thinking, and other more political concerns, has pushed spectrum policy and auction rules in the direction of revenue extraction. This has proven costly. Among these costly policies are such measures or strategies as: delays in auctioning licenses, as the government waits until bids will be higher; reserve prices, which leave licenses unsold if minimum bids are not received; bidding credits for weak bidders, intensifying competition with strong bidders; and reducing the number of licenses sold, inducing simple monopoly power.

Indeed, each of the measures in some way seeks to reduce the probability-adjusted supply of spectrum in the mobile market. This is costly in that spectrum is a key input into wireless services. If it is withheld—or delayed, pared back, or restricted in its use—the market cannot fully optimize (or cost minimize) in supplying services. More costly alternatives will be

[30] Klemperer, *What Really Matters in Auction Design*, *supra* note 1, at 179.

undertaken, such as deploying more expensive technologies, building more infrastructure (base stations, with greater cell splitting), or simply reducing network access through higher prices.

Because the social gains from additional license receipts are relatively tiny, the focus of policy makers interested in maximizing consumer welfare is rightly on the mission of market efficiency. Yet, much spectrum allocation has become distracted. Policies are offered to intentionally create market power, increasing license rents: "[S]ince alternative taxes entail an enormous welfare loss, it is even optimal to accept some deviation from efficiency if this gives rise to more revenue."[31] But because this "deviation from efficiency" raises revenue in the input market, while damaging consumer surplus in the output market, this strategy faces a stiff burden. This Article shows that restricting the productive use of radio spectrum is, generally, a relatively expensive means to secure public funds from the first dollar raised. Pursuing such regulatory strategies tend to be penny wise and pound foolish.

III. "Success" and "Fiascoes"

> [T]he economic theorists advising the Swiss government on its 3G auction favored a multi-unit ascending auction . . . [and] also proposed setting a high reserve price. . . .
>
> But serious reserve prices are often unpopular with politicians and bureaucrats who—even if they have the information to set them sensibly—are often reluctant to run even a tiny risk of not selling the objects, which outcome they fear would be seen as "a failure."[32]

A. General Evaluations

Wireless license auctions are typically ranked and evaluated according to receipts raised. This metric is sometimes defined in gross revenues, revenue per capita, or revenue per MHz per capita (reflecting bandwidth allocated to the licenses sold). Higher bids are considered evidence

[31] Wolfstetter, *The Swiss UMTS Spectrum Auction Flop*, *supra* note 1, at 6.

[32] PAUL KLEMPERER, AUCTIONS: THEORY AND PRACTICE 138 (2004).

of superior auction design. Table 3 shows results for the European 3G auctions, the "third generation" licenses supporting high-speed data services in addition to voice (1G) and narrowband data (2G) services. The auctions of these licenses in the E.U. countries occurred in 2000–2001, and constitute the last major wave of mobile licensing.[33]

Klemperer identifies the British auction as successful, while rating auctions in Austria, Netherlands and Switzerland as fiascoes.[34] He concludes that the circumstances separating successful from unsuccessful license assignments demonstrates that: "[A]uction design is not 'one size fits all.' The ascending design that worked very well for the UK worked very badly in the Netherlands, Italy, and Switzerland because of entry problems, and this was predictable (and predicted) in advance."[35] A similar appraisal of the Swiss auction is offered by Paul Milgrom, who adds a policy prescription: "Swiss authorities could have achieved a higher price if they had wished. The auction rules could have provided that if few bidders entered the auction, the government would sell the spectrum in the form of three licenses, rather than four, to create meaningful competition."[36]

Auctions distribute intermediate inputs. Value is ultimately created via the use of radio spectrum to provide services to end users. The degree to which licenses enable productive use of airwaves is not perfectly correlated with the price of licenses sold, even when the competitive

[33] In 2010, most E.U. countries are preparing for the auction of 4G licenses which often involve reallocating spectrum from the television band as per the transition to digital TV broadcasting. The so-called "digital dividend" occurs when the move from analog to digital technology effectively reduces the bandwidth required for the same (or greater) terrestrial broadcasting services. *See, e.g.*, Thomas W. Hazlett, Jurgen Müeller & Roberto Muñoz, *The Social Value of TV Band Spectrum in European Countries*, 8 INFO 62 (2006).

[34] *See generally* Klemperer, *How (Not) to Run Auctions*, *supra* note 1. The auction in the Netherlands is rated a "miserable failure" in Binmore & Klemperer, *supra* note 1, at C74, C93.

[35] Klemperer, *How (Not) to Run Auctions*, *supra* note 1, at 844.

[36] PAUL MILGROM, PUTTING AUCTION THEORY TO WORK 209 (2004).

bidding process succeeds in extracting the present value of expected profits.[37] Klemperer notes that "the outcome of an auction is driven by bidders' profits, not by the welfare of consumers or society as a whole" and offers guidance for constructing certain pro-competitive outcomes.[38]

But the conflict between efficiency in output markets and the maximization of input market license sales has generally escaped attention. And the more fundamental question of how rival spectrum policies affect consumer welfare is not systematically addressed in this literature.[39] Output reducing policy conclusions are often reached solely by an examination of how auction bidding is impacted.

[37] Of course, the same is true of output market goods and services. With monopoly power, prices and revenues may increase over competitive levels not due to value-added, but output restriction.

[38] Klemperer, *What Really Matters in Auction Design*, *supra* note 1, at 177.

[39] There are many treatments of economic efficiency in spectrum policy, but they are largely divorced from the auction literature. *See, e.g.*, WILLIAM J. BAUMOL & DOROTHY ROBYN, TOWARD AN EVOLUTIONARY REGIME FOR SPECTRUM GOVERNANCE: LICENSING OR UNRESTRICTED ENTRY? (2006); Stuart Minor Benjamin, *Spectrum Abundance and the Choice Between Private and Public Control*, 78 N.Y.U. L. REV. 2007 (2003); Gerald R. Faulhaber, *The Future of Wireless Telecommunications: Spectrum as a Critical Resource*, 18 INFO. ECON. & POL'Y 256 (2006); Gerald R. Faulhaber & David J. Farber, *Spectrum Management: Property Rights, Markets, and the Commons* (Working Paper No. 02-12, 2002), *available at* http://assets.wharton.upenn.edu/~faulhabe/SPECTRUM_MANAGEMENTv51.pdf; Thomas W. Hazlett, *Liberalizing U.S. Spectrum Allocation*, 27 TELECOMM. POL'Y, 485 (2003); Thomas W. Hazlett, *Wireless Craze, the Unlimited Bandwidth Myth, the Spectrum Auction Faux Pas, and the Punchline to Ronald Coase's 'Big Joke': An Essay on Airwave Allocation Policy*, 14 HARV. J.L. & TECH. 335 (2001) [hereinafter Hazlett, *Wireless Craze*]; Evan Kwerel & John Williams, *A Proposal for a Rapid Transition to Market Allocation of Spectrum* (Fed. Commc'ns Comm'n Office of Plans & Policy, Working Paper No. 38, 2002), *available at* http://wireless.fcc.gov/auctions/conferences/combin2003/papers/masterevanjohn.pdf; Bruce M. Owen & Gregory L. Rosston, *Spectrum Allocation and the Internet*, *in* CYBER POLICY AND ECONOMICS IN AN INTERNET AGE (W. Lehr & L. Pupillo eds., 2002); Gregory L. Rosston & Jeffrey S. Steinberg, *Market-Based Spectrum Policy to Promote the Public Interest*, 50 FED. COMM. L.J. 87 (1997); Pablo Spiller & Carlo Cardillo, *Towards a Property Rights Approach to Communications Spectrum*, 16 YALE J. ON REG. 1 (1999); Lawrence J. White, *"Propertyzing" the Electromagnetic Spectrum: Why It's Important, and How to Begin* (N.Y.U. Stern Sch. of Bus. Working Paper No. 00-08, 2000), *available at available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1292687. An attempt to bridge this gap is found in Thomas Hazlett & Roberto E. Muñoz, *A Welfare Analysis of Spectrum Allocation Policies*, 40 RAND J. OF ECON. 424 (2009).

TABLE 3. PRICES PAID FOR 3G LICENSES IN EUROPE[40]

Country	Date	(US$/pop-MHz)	Euros/pop
Austria	Nov. 2000	0.604	100
Belgium	Mar. 2001	0.375	45
Denmark	Sept. 2001	0.623	95
Germany	Aug. 2000	3.884	615
Greece	July 2001	0.394	45
Italy	Oct. 2000	1.494	240
Netherlands	July 2000	1.093	170
Switzerland	Dec. 2000	0.120	20
UK	Apr. 2000	4.310	650

The common use of this single metric is curious given the historical economic case for auctions. The primary advantage put forth as a reason to adopt auctions in place of "beauty contests" or lotteries was that competitive bidding distributed licenses to those firms that could use them most productively. This reformed arbitrary awards marked by a rent seeking process that made socially wasteful investments in pursuit of political favors.[41] Given that licenses were generally reassigned in secondary markets, allowing the price system to select initial licensees afforded clear efficiencies, assigning spectrum rights directly to highest valued users. This improved market performance and economized transactions, including bargaining costs incurred in license sales. Soon after implementation auctions were indeed credited with improving spectrum policy, eliminating the time and expense of non-auction assignments.[42]

[40] The source of the information in Table 3 is supplied by regulators in each country. The last column is from Paul Klemperer, *How (Not) to Run Auctions*, *supra* note 1, at 830.

[41] Economic analysis of radio spectrum essentially began with Leo Herzel's 1951 call for auctions, followed by Ronald Coase's 1959 analysis. *See* Leo Herzel, *"Public Interest" and the Market in Color Television Regulation*, 18 U. CHI. L. REV. 802 (1951); Ronald H. Coase, *The Federal Communications Commission*, 2 J.L. & ECON. 1 (1959); *see also* Thomas W. Hazlett, *Assigning Property Rights to Radio Spectrum Users: Why Did FCC License Auctions Take 67 Years?*, 41 J.L. & ECON. 529 (1998); Hazlett & Michaels, *supra* note 2; Thomas W. Hazlett, David Porter & Vernon L. Smith, *Radio Spectrum and the Disruptive Clarity of Ronald Coase*, 54 J.L. & ECON. (forthcoming, Nov. 2011); Evan Kwerel & Alex D. Felker, *Using Auctions to Select FCC Licensees* (Fed. Commc'ns Comm'n Office of Plans & Policy, Working Paper No. 16, 1985).

[42] *See generally* CONG. BUDGET OFFICE, WHERE DO WE GO FROM HERE? THE FCC AUCTIONS AND THE FUTURE OF RADIO SPECTRUM MANAGEMENT (1997); FED. COMMC'NS COMM'N, FCC 97-353, THE FCC REPORT TO CONGRESS ON SPECTRUM AUCTIONS (1997).

Next to these economic gains, the diversion of rents to the public treasury was seen as a windfall for government. These revenues could displace tax funds, reducing economic distortions.[43] Economists have generally cited all three major sources of greater efficiency: (1) licenses go to the most efficient firms with less transaction cost; (2) rent seeking expense is reduced; and (3) rents to the public treasury replace revenues raised via activity-distorting taxes.[44]

Both economists and policy makers have issued pro forma caveats warning against regulatory approaches that aim to maximize revenues. But they have generally proceeded with a single-metric approach that credits greater revenues to greater "success" when evaluating auctions results. Klemperer argues the case for auctions thusly:

> Even relatively unsuccessful auctions, such as the Netherlands and Italian spectrum auctions, were probably more successful than the "beauty contest" administrative hearings used to allocate third-generation spectrum in several other European countries. For example, the Spanish beauty contest yielded just 13 euros per head of population, but generated considerable political and legal controversy and a widespread perception that the outcome was both unfair and inefficient . . . .[45]

Professor Klemperer's conclusion is surely correct—the efficiencies of competitive bidding compare favorably with those of "beauty contests." But categorizing the Dutch and Italian policies as "relatively unsuccessful," an assertion based wholly on the fact that license sales prices were low, is a deeply flawed approach to spectrum policy.

The position implicitly assumes that wireless licenses are simply "spectrum," and that a natural resource is being sold to market participants, much like oil leases or timber rights. The analogy is sound in some respects, but faulty in others. One problem lies in the fact that the

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[43] *See* Cramton, *Spectrum Auctions*, *supra* note 1.

[44] *Id.*

[45] Klemperer, *What Really Matters in Auction Design*, *supra* note 1, at 186.

rights that wireless licenses confer are not valued according to substitutes in global commodity markets, but according to expectations of profits in wireless operating markets. These markets (and the profits they generate) are highly sensitive to the policies embedded in the licenses being sold. For example, regulators may increase or decrease license bids by increasing or decreasing the number of licenses assigned, the spectrum allocated to these licenses, the rules governing such licensees, and so on.

The upshot is that the sale of a government-owned commodity (say, oil or timber) generally captures (simply) a transfer price for the public. In spectrum, however, the policies enacted within the spectrum allocation scheme will heavily influence the bids made. Whereas the revenues collected for the standard resource auction are exogenous to the operating market, the revenues collected in the sale of wireless licenses are endogenous. Rules that limit wireless service competition may drive up license prices, but such rules do not leave the operating market unaffected. Quite the reverse; consumers are harmed. Such harms must be explicitly incorporated in an analysis pronouncing spectrum policies "successful" or "fiascoes."

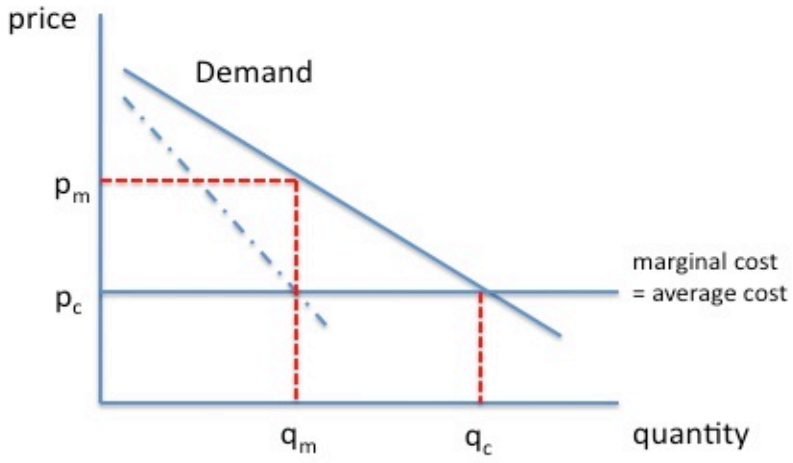
B. Demsetz Auctions

Harold Demsetz proposed an alternative to traditional public utility regulation via a bidding scheme for franchises.[46] In instances where natural monopoly obtained, such that one firm could satisfy market demand more cheaply than competitors, a sole provider could be selected by competitive bidding. Specifically, firms' bids would not be cast as payments but in the form of price schedules—the rate at which the company would offer to sell services to

[46] *See* Harold Demsetz, *Why Regulate Utilities?*, 11 J.L. & ECON. 55 (1968).

consumers. Thus, the market could capture the productive efficiencies of natural monopoly and the allocative efficiencies of market competition.[47]

FIG. 4. DEMSETZ AUCTIONS AND LICENSE PRICES



In situations such as the one portrayed in Figure 4, a service franchise (monopoly or otherwise) can operate according to constant marginal costs (equal to average unit costs). If firms bid for one franchise to serve the entire market (defined by the demand curve) and regulators select the lowest price bid,[48] then that price equals p_c and the firm—mandated by regulation to provide service throughout the life of the franchise at that price—will produce a competitive level of output, q_c. Given that the Demsetz Auction constrains potential monopolists to reveal their long-term retail prices, a competitive outcome obtains. A robust franchise bidding process should not produce any government revenues, since no profits are made when the price

[47] *See generally* WILLIAM J. BAUMOL, JOHN C. PANZAR & ROBERT D. WILLIG, CONTESTABLE MARKETS AND THE THEORY OF INDUSTRY STRUCTURE (1982).

[48] "Price" can be thought of the lowest price-per-unit. In reality, however, price will typically consist of an entire schedule of rates. (Monthly service rates may be lower in one bid, but installation charges higher—or reliability of service lower.) Determining which bid implies "the lowest price" will be a non-trivial exercise. On such practical issues, see Oliver E. Williamson, *Franchise Bidding for Natural Monopolies—in General and with Respect to CATV*, 7 BELL J. ECON. 73 (1976); Thomas W. Hazlett, *Private Monopoly and the Public Interest: An Economic Analysis of the Cable Television Franchise*, 134 U. PA. L. REV. 1335 (1986).

equals p_c, which equals average cost. Instead, consumer welfare is maximized, albeit with a monopoly supplier.

Were regulators to, alternatively, assign the franchise to the highest price (lump sum payment bid to the government), the economic result markedly changes. The winning franchisee would bid the net present value generated by setting the price to p_m, the rents available from operating as a monopolist restricting output from q_c to q_m. While the government recovers the value of the franchise (rents are transferred to the public treasury), consumers lose the low prices of competition. Moreover, the monopoly prices charged to customers distort economic activity, inducing deadweight losses.

Regulators assigning wireless licenses face this same basic dichotomous policy choice. Importantly, they will not generally be able to avail themselves of a Demsetz Auction to remedy the potential output-restriction problem when licenses are sold for their highest bids. Such an auction requires that the product be stable and well-defined, else the firms' price schedule bids cannot be quantitatively ranked.[49] Without such transparency, the bids are reduced to competing proposals to be evaluated on the qualitative standards imposed by regulators. This is precisely the "beauty contest" or "comparative hearings" process that competitive bidding was designed to replace.

Mobile wireless networks and services are neither stable nor well-defined; the marketplace is rapidly evolving. Rate regulation for wireless services was abandoned in the United States by federal statute in 1993, having failed to improve prices for consumers even

[49] *See* discussion in note 48, *supra*.

under the cellular duopoly then in place.[50] Demsetz Auctions are not a realistic option compared to pro-competitive policies that avoid franchise monopoly by licensing rival wireless operators.

Spectrum regulators counter market power by issuing multiple licenses and making spectrum inputs available to sustain and enhance network rivalry. This will tend to produce the economic outcome sought in the Demsetz Auction and capture license rents for the public treasury. But tension between efficiency in outputs and value-capture in inputs is a built-in feature. When the focus of the regulator shifts from lower prices for consumers to higher prices for the franchise, economic distortions can easily occur.

C. License Prices and Property Rights

The avoidance of monopoly is well understood. What bears much less notice is that the restrictions embedded into wireless licenses—such as rules limiting services to just voice (1G) or voice and narrowband data services (2G)—constitute analogous output restrictions. Where such legal limitations reduce competitiveness they can make licenses more valuable. These license rents may be captured via competitive bidding for assignment of the rights, but this is a relatively high-cost way to raise public revenues, as it distorts retail wireless markets. When license sales are evaluated on the basis of revenues raised, misleading appraisals result.

It may seem obvious that licenses that are given broader scope—fuller, more complete property rights to the allocated radio waves—would fetch higher prices. Licensees would have more opportunities to productively use frequencies and fewer (if any) restrictions blocking profitable new technologies or business models.

[50] Babette E.L. Boliek, *Wireless Net Neutrality Regulation and the Problem with Pricing: An Empirical, Cautionary Tale,* 16 MICH. TELECOMM. & TECH. L. REV. 1, 4 (2009).

Yet this is not the case.[51] Countries that have instituted decidedly liberal reforms, granting wireless operators qualitatively wider scope to control airwaves, saw prices about sixty percent *lower* than in other markets, all else equal, in a study of thirty-eight mobile license auctions held in twenty-four countries between 1995 and 2001.[52] This result supports the view that by relaxing regulation of the input (spectrum) market, regulators can improve future competitiveness in the output (mobile services) market. The anticipation of greater rivalry produces lower bids.

This result seems counter-intuitive to some because additional property rights are an incremental gain to the owner. With wireless licenses, however, property rights are defined categorically. When regimes alter rights, pro forma rules change for classes of assets (in this case, spectrum use authorizations). Additional rights for one licensee (a gain for that licensee) are accompanied by additional rights for current or potential rivals (a loss). The effect of the incremental rights on license value is therefore ambiguous.

What is unambiguous, however, is the direction of change in consumer surplus. Customers gain when market rivalry intensifies, and liberalization (expanded spectrum use rights and increased frequency allotments) strongly drives this market outcome.[53] The effect is visible in license bids. This finding, combined with knowledge about the relative magnitudes of social surplus in the wireless market (i.e., that the gains from efficiency overwhelmingly flow to consumers rather than to firm profits), has important implications. What matters most in spectrum allocation policy is the availability of spectrum bandwidth and broad property rights to productively deploy it—not license revenues.

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[51] *See* Thomas W. Hazlett, *Property Rights and Wireless License Values*, 51 J.L. & ECON. 563 (2008).

[52] *Id.* at 564–65.

[53] *See* sources cited *supra* note 39.

D. Examples of "Cart Before the Horse," and Vice Versa

Specific examples illustrate how license assignment methods are nested in the spectrum allocation regime. Policies with clear output market efficiency implications are commonly evaluated solely on the basis of how such reforms alter auction receipts. This approach is not universally the case, however, as some policies inflicting inefficiencies are rejected. These latter policies—some of which artificially create market power, making licenses more valuable and bids therefore higher—are sometimes identified as instances in which auction design puts "the cart before the horse."[54]

The appraisal is well put. Yet, there are many instances in which "cart before the horse" reasoning is uncontested. The following arguments by Paul Milgrom, analyzing spectrum auction policies, frame the general approach taken by economists.

> When the likely winner of the auction is not in much doubt, the prospect of incurring unrecoverable costs can depress entry. Spectrum auctions in Germany, Italy, Israel, and Switzerland have all suffered from insufficient entry. . . .
> [W]e show how a seller can structure an auction to encourage entry, increase competition, and promote higher prices.[55]

The problem identified is that demand for licenses is insufficiently intense. In a low demand situation, even if licenses are highly valuable to some parties, these parties are not forced to bid aggressively, and rivalry in the auction is weak. As a result, auction receipts lag. If license auctions are seen as purely a means to an end—enabling productive use of airwaves—"low participation" makes rights distribution *easier*. High demanders outbid others and deploy the rights sold.

[54] Klemperer, *What Really Matters in Auction Design*, *supra* note 1, at 185.

[55] MILGROM, *supra* note 36, at 234.

Of course, a private asset owner facing this situation would likely employ measures to extract a fuller proportion of value from the buyer. This follows from presumed wealth-maximizing behavior. But a government facilitating access to a valuable resource should, alternatively, strive to maximize social welfare. To achieve that goal, the policy maker must enable efficiency in the post-auction output market.[56] Promoting measures to generate demand for licenses that compromise such efficiencies put the "cart before the horse." This is seen in the evaluation of the suggested policy remedies, which include first-price auctions, reserve prices, bidding credits, and the withholding of licenses, each considered here.

1. First Price Versus Ascending Price Auctions

Paul Klemperer establishes that a simple ascending auction is not an efficient assignment tool due to problems related to collusion and entry deterrence:

> In an ascending auction, there is a strong presumption that the firm that values winning the most will be the eventual winner, because even if it is outbid at an early stage, it can eventually top any opposition. As a result, other firms have little incentive to enter the bidding and may not do so if they have even modest costs of bidding.[57]

Klemperer's solution to the problems associated with the ascending auction format is to make it more robust to collusion and entry deterring behavior. This is achieved with the Anglo-Dutch design[58] or a first-price sealed-bid auction, which likely generate higher revenues for the auctioneer. Evidence from wireless telephone license auctions suggests that revenues collected

[56] This is not merely a normative view, but a result of economic efficiency. A private owner competes with other private owners in the creation or discovery of scarce resources; the value of those resources drives the quest for ownership. In the case of government allocation of radio spectrum, the state assumes monopoly control over valuable natural resources in order to facilitate productive exploitation. Even where various public interests are pursued, including government-regulated or government-owned spectrum allocations, the welfare-maximizing path is to achieve such objectives in an efficient manner. This implies that the state should not monopolize resources, but seek to enable competitive forces to expand social opportunities.

[57] Klemperer, *What Really Matters in Auction Design*, *supra* note 1, at 172.

[58] *See id.* at 170.

in sealed-bid auctions (first- or second-price) generally exceed revenues generated by other formats.[59] But there can be costs associated with such approaches, including the increased probability that a "weak" player will out-bid a "strong" one, displacing a more efficient supplier in the output market. When this happens, higher costs offset some economies gained by more efficient rent extraction in the license auction.

The intended point is not to argue against first-price sealed bids or to dispute the conclusion that these auctions raise higher revenues. Rather, this Article stresses that welfare considerations should be included in the cost-benefit calculus when input or output markets are impacted by regulatory changes. The social losses associated with auction rules designed to encourage participation by weak bidders are particularly pronounced in the U.S. PCS C block auctions, discussed below.

2. Reserve Prices

The sequential Turkish auctions held in 2000 mandated that the price for the second license equal or exceed the price bid by the winner of the first.[60] This prompted the first auction winner to bid so aggressively that a second operator would not pay the steep entry fee. Klemperer appropriately labels the monopoly output market result the "Turkish fiasco" and a "tale of woe.[61]

Yet, the inefficient result is embedded in reserve prices. The purpose of a reserve (or reservation) price is generally to raise bids by blocking the sale of a license when no bid is made exceeding a minimum level set by the regulator. In some instances, then, licenses will remain unsold, yielding less market competition. Moreover, regulators typically allow the bandwidth

[59] Hazlett, *supra* note 51, at 572.

[60] Klemperer, *What Really Matters in Auction Design*, *supra* note 1, at 177–78.

[61] *Id.*

allocated to the unsold licenses to remain idle—a second source of efficiency loss imposed by reducing the capacity (or, equivalently, raising the opportunity costs) of incumbent wireless operators. Nonetheless, economists ubiquitously advocate such policies,[62] advising governments "to withhold supply and set reserve prices to improve revenues."[63]

The effect of the higher retail prices that may ensue are excluded from the economic analysis, which therefore presents an incomplete, asymmetric evaluation. Empirically, this Article estimates the costs associated with leaving licenses unsold due to reserve prices imposed in Belgian and Greek 3G auctions held in 2001, and finds the miscue of decidedly material magnitude.

It is illustrative that the remedy to the "Turkish fiasco" attempted by Turkish policy makers was not entirely well received in the scholarly literature. When the government moved to moot the monopoly by issuing an additional license, thereby lowering the reservation price *ex post*, the policy shift brought was challenged on the grounds that it undermined confidence in government auction rules.[64]

Regulatory certainty is an important goal, but this Article argues that the policy take-away is virtually the reverse: it is dangerous for governments to commit to policies that exclude competitors so as to encourage higher auction bids. Once that process begins, the state becomes complicit in a scheme to inefficiently restrict output, as in a collusive agreement—indeed, the government structured the market, defined the rules, sold the exclusionary rights created, and

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[62] *See* McMillan, *Selling Spectrum Rights*, *supra* note 1, at 159; Klemperer, *What Really Matters in Auction Design*, *supra* note 1, at 176, 178.

[63] Lawrence M. Ausubel & Peter Cramton, Vickrey Auctions with Reserve Pricing 12 (June 28, 1999) (unpublished manuscript) (on file with the University of Maryland).

[64] "The credibility of reserve prices is of special importance… [more competition may be achieved, but] "at what cost to the credibility of its future auctions?"[64] Klemperer, *What Really Matters in Auction Design*, *supra* note 1, at 177.

cashed the licensee's check paid in advance to exploit the opportunity at hand. Clearly, this is another case of "cart before the horse."

3. Bidding Credits as a "Free Lunch Policy"

Another solution to the "low participation" problem that has gained currency among economists is the use of bidding credits:

> The government could allow any firm to bid on any license, but give the designated firms a price preference. With a preference of, say, 10 percent, a designated firm would win if its bid was no more than 10 percent less than the highest nondesignated-firm bid. This is a free-lunch policy. It would not only address the public-policy goal of increasing the number of licenses won by the designated firms, but it would also actually increase the government's revenue.[65]

This approach received a boost after the FCC's initial use of credits appeared to yield additional revenues.[66] But even before disaster struck in the PCS C and F block auctions in 1996 and 1997, it was deducible that substantial expected costs would be incurred by any mechanism that risked assigning licenses to relatively inefficient suppliers. Indeed, the basic efficiency motivation for adopting license auctions is that competitive bidding awards operating rights to those firms most able to provide high-quality, low-cost service to the public.

Paul Milgrom makes a strong case against beauty contests and lotteries by specifically rejecting the idea that secondary markets correctly adjust for initial awards: "According to a famous result in mechanism design theory—the Myerson-Satterthwaite [M-S] theorem—there is no way to design a bargaining protocol that avoids this problem: delays or failures are inevitable in private bargaining if the good starts out in the wrong hands."[67] Bidding credits impose just the inefficiency that the M-S theorem identifies. Yet, such policies are advanced as revenue-raising

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[65] McMillan, *Selling Spectrum Rights*, *supra* note 1, at 158.

[66] *See* Ian Ayres & Peter Cramton, *Deficit Reduction Through Diversity: A Case Study of How Affirmative Action at the FCC Increased Auction Competition*, 48 STAN. L. REV. 761 (1996).

[67] MILGROM, *supra* note 36, at 21.

devices without consideration of inefficiency offsets. The social costs of moving away from market-based awards are implicitly regarded as exogenous to the process.

However, that is not the case, as vividly seen in the U.S. PCS designated entity (DE) fiasco. Small businesses and rural phone companies (qualified DEs) extended bidding credits and long-term low-interest loans for PCS C (30 MHz) and F (10 MHz) licenses. The result was widespread over-bidding followed by licensee bankruptcies, after which no use was made of the allocated spectrum while court battles (which the government eventually lost) played out over nearly a decade.[68]

As this Article shows below, the social loss associated with an estimated 30 MHz reduction in mobile services spectrum over eight years—a conservative definition of what was incurred—is orders of magnitude larger than any plausible efficiencies associated with rent extraction due to enhanced auction bids. That the U.S. experience can be attributed in large measure to poor implementation, though true, is irrelevant. The rules are endogenous to the handicapping policy. Whatever preferences are crafted, credits increase weak bidders' chances of winning licenses, which incurs social costs and, occasionally, policy fiascoes inflict much larger costs as well. An optimal spectrum policy would properly account for all of these costs.

4. Withholding Licenses

Economists critical of the Italian 3G auction design have rejected rules intended to render the Italian wireless market structure less competitive. Klemperer writes that the Italian government "stipulated that if there were no more 'serious' bidders . . . than licenses, then the

[68] *See* Thomas Hazlett & Babette Boliek, *Use of Designated Entity Preferences in Awarding Wireless Licenses*, 51 FED. COMM. L.J. 639 (1999); Robert W. Crandall & Allan T. Ingraham, *The Adverse Economic Effects of Spectrum Set-Asides*, 6 CAN. J.L. & TECH. 131 (2007).

number of licenses could, and probably would, be reduced."[69] Klemperer pronounces this policy "fundamentally flawed . . . [because] it is putting the cart before the horse to create an unnecessarily concentrated mobile-phone market to make an auction look good."[70] This Article endorses this departure from revenue-maximization—and notes that the departure directly undercuts the curiously universal appeal of binding reserve prices.

E. Costs of Spectrum Allocation or License Assignment Delays

Huge costs have historically been imposed on consumers and businesses by deterring competitive entry or new technologies. For instance, it is estimated that impeding cellular telephone service by a decade cost the U.S. economy about $86 billion in lost productivity.[71] Given that a decade and a half of license auctions have produced about $52 billion in actual receipts for the U.S. Treasury,[72] this single spectrum policy inefficiency is likely to have cost society five times the claimed public finance efficiencies (assuming $0.33 of lost productivity is averted for every public dollar gained).[73]

1. UK 3G Delays

In the British 3G auction, Binmore and Klemperer note that a three-year planning phase was used to good cause, improving the policies adopted.[74] Yet the analysis does not consider the

[69] Klemperer, *What Really Matters in Auction Design*, *supra* note 1, at 185.

[70] *Id.*

[71] Charles Jackson et al., ESTIMATE OF THE LOSS TO THE UNITED STATES CAUSED BY THE FCC'S DELAY IN LICENSING CELLULAR TELECOMMUNICATIONS, NERA (1991).

[72] MOVING FORWARD, *supra* note 21, at 11. This total includes $13.7 billion in the 2006 Advanced Wireless Services (AWS) auctions in September 2006, $19.1 billion in the March 2008 700 MHz license auctions, and $19.1 billion in the other sixty-eight auctions held 1994–2008. *Id.*

[73] Hazlett describes a long list of wireless technologies delayed or deterred by spectrum allocation policies in a section entitled "Silence of the Entrants." Hazlett, *Wireless Craze*, *supra* note 39, at 375–402.

[74] Binmore & Klemperer, *supra* note 1, at C74, C90.

loss in service to the public constituted by the waiting period.[75] This Article's simulation, summarized below, suggests that the cost to the UK economy of this three-year delay was approximately $6.5 billion. Considering that the UK 3G auction raised $34 billion, and assuming social savings of $0.33 per dollar raised, this delay offset around sixty percent of the *entire* public finance dividend.

2. The United States' 3G Delay

The three-year UK 3G rollout constitutes rapid progress, however, compared to 3G licensing in the United States. In 1996, FCC Chairman Reed Hundt proposed a reallocation of UHF-TV spectrum, from channels 60 to 69, and licenses were essentially ready to auction by 2000. A congressional statute mandated such—but eight auction postponements occurred through 2004.[76] Economists actually endorsed some of the delays.[77] Finally, with the 700 MHz license auction (FCC Auction No. 73) in March 2008 these licenses were assigned and, with the turn-off of analog TV broadcasting on June 12, 2009, the spectrum was made available for use in alternative (non-television) services.

More generally, U.S. spectrum allocation underwent a "lost decade." Between the allocation of PCS (or 2G) licenses in 1994, and their assignment by auction in 1995–1997, no substantial spectrum allocations for mobile services were made until the AWS license auctions in

[75] Similarly, van Damme notes that the Netherlands allocated spectrum for 2G licenses in March 1995, but did not assign such licenses until February 1998, implying that the delay resulted from consideration of the decision to use competitive bidding. Van Damme, *supra* note 1, at 5.

[76] Hazlett shows how the argument that the unoccupied spectrum should be preserved to deliver HDTV, at some unspecified date in the future, has been used to delay or block new services. Hazlett, *Wireless Craze*, *supra* note 39, at 466.

[77] Ronald Harstad, Aleksandar Pekec, and Michael Rothkopf filed a Comment with the Federal Communications Commission in January 2001. Ronald M. Harstad et al., Verizon Is Right: Delay Auction No. 31, Comment on FCC DA 01-143 (Jan. 24, 2001). The authors filed another Comment on February 19, 2002, which urged further delay for Auction No. 31. Ronald M. Harstad et al., Thorough Analysis of Package Bidding Procedures Is Still Needed, Comment on FCC DA 02-260 (Feb. 19, 2002). The filings focused solely on the possibility that rent extraction might have been reduced without further delays.

2006. In other words, the United States simply missed the 3G licensing round undertaken in the UK and most other advanced economies in 2000–2001. And it did so intentionally, to satisfy policy choices.

In its first spectrum policy initiative, the Bush Administration prepared a March 2001 budget statement that recommended that 3G auctions be delayed until September 2004, calling this "a 'win-win' for all parties involved" and a "good telecom policy."[78] The "win-win" referred to higher receipts for government (as bids were expected to increase over time) and gains for incumbent carriers who requested that new industry capacity be delayed. Only consumer interests and the health of the overall U.S. economy were omitted from the "win-win" analysis.[79]

3. Endemic Spectrum Under-Allocation

The problem of spectrum under-allocation, wherein a regulatory bottleneck blocks the flow of bandwidth to its most highly valued employment, is found in the United States and many other countries. This restricts the services provided to end users, raises retail prices, and reduces Consumer Welfare compared to what would be obtained under a more liberal spectrum allocation regime. Yet, perhaps the easiest way to underscore the general problem is to look at a specific country or region where the amount of spectrum allocated to mobile services—the dominant value-generating application in the modern economy—is far below that allocated elsewhere.

[78] Thomas W. Hazlett, *Hostage Standoff*, BARRON'S, March 19, 2001.

[79] In the interests of *reductio ad absurdum*, this Article abstracts from the numerous other social interests harmed by the intentional policy of delay. Among these are telecommunications equipment manufacturers (shareholders and employees); U.S. businesses using wireless communications as inputs; public safety organizations that rely on wireless networks.

Latin America is a region, where such endemic under-allocation is visible. On average, countries there allowed only about 100 MHz to be used by mobile operators by 2004. This was far below the allocations in, for instance, the European Union, where countries averaged 266 MHz.[80] The unallocated spectrum did not serve higher-valued uses, but essentially lay idle. And countries with more generous allocations—such as Guatemala, with 140 MHz—exhibited lower prices and higher usage than similar countries that artificially restricted wireless inputs, such as Panama (50 MHz), Honduras (65 MHz), and Nicaragua (85 MHz).[81] Such policy outcomes far outweigh license assignment choices and should be grasped as central to the regulatory analysis.

IV. Taxing Liberalization

Yet, rather than stress the fundamental mission of improving market access to radio spectrum, much of the policy analysis goes in just the opposite direction. One line of argument in the economics literature has developed that, "just as a competitive telecommunications market contributes to . . . welfare, so might high auction revenue, and therefore both objectives should be considered."[82] Hence, some seek to balance the social gains from higher license revenues against the costs of super-competitive pricing resulting from the imposition of suboptimal market structure. "[S]ince alternative taxes entail an enormous welfare loss, it is even optimal to accept some deviation from efficiency if this gives rise to more revenue."[83]

This logic was developed into a policy proposal by Rothkopf and Bazelon, which attempts to extract rents from wireless licensees whose rights are expanded through

[80] Thomas W. Hazlett & Roberto E. Muñoz, *Spectrum Allocation in Latin America: An Economic Analysis*, 21 INFO. ECON. & POL'Y 261, 261 (2009).

[81] *Id.* at 263 tbl. 1.

[82] Van Damme, *supra* note 1, at 6.

[83] Wolfstetter, *The Swiss UMTS Spectrum Auction Flop*, *supra* note 1, at 6.

liberalization.[84] Suppose, for instance, that a cellular phone operator is licensed to deliver analog service, but is then awarded the option to use digital technology. The enhanced discretion constitutes an additional property right, and the ownership of that (new) right may confer a windfall gain on the licensee.[85]

Rothkopf and Bazelon are critical of a "big bang" proposal by FCC policy analysts,[86] in which existing licensees would be granted use of frequencies in ways not specified in their licenses. This would "distribute expanded use rights to incumbents for free or at far below their value."[87] Rejecting the "approach to spectrum management that focuses solely on the efficiency gains associated with distributing the expanded and valuable license rights," they devise a way to extract value from incumbents granted new flexibility.[88]

The problem with simply auctioning the new rights is that the incumbents will clearly be the highest bidders. Entry into the auction will be lackluster (given fixed costs of participating) and serious bidding will be rarer still, given the expectation that license rights are worth far more to current networks than to newcomers.

This foreordained outcome might be seen as an opportunity to save resources by assigning rights to incumbents without an auction, a transaction cost-minimizing strategy.[89] Yet, if this approach reduces transfers to the government, license auction revenue will presumably

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[84] Michael H. Rothkopf & Coleman Bazelon, *Interlicense Competition: Spectrum Deregulation Without Confiscation or Giveaways* (New Am. Found. Spectrum Pol'y Program, Working Paper No. 8, 2003).

[85] Rothkopf and Bazelon assert that expanded rights will unambiguously bestow a "giveaway." *Id.* at 3. Yet, additional rights distributed to a class of licensees may reduce rents, as explained above; the windfall may be positive or negative.

[86] *Id.* at 4; *see also* Kwerel & Williams, *supra* note 39, at 4.

[87] Rothkopf & Bazelon, *supra* note 84, at 4.

[88] *Id.*

[89] *See* Harold Demsetz, *When Does the Rule of Liability Matter?*, 1 J. LEGAL STUD. 13 (1972); Ronald H. Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1 (1960).

instead be raised by activity-distorting taxes. It is this latter consideration that motivates the policy proposal.

To extract revenues from incumbents receiving new rights, Rothkopf and Bazelon advocate that the regulatory authority withhold some portion of new rights from the market, pitting incumbents against each other in bidding for a reduced number of "windfall rights."[90] Say that there are 100 analog cellular phone carriers in 100 (or fewer) markets, and each could profitably deploy digital technology that is prohibited by current license restrictions. Instead of awarding 100 digital transmission rights (DR), a lesser number would be issued, with incumbents forced to bid (if they seek to obtain DR). The point of this restriction is to induce scarcity, driving the market-clearing price of DR above zero.

In general, the lower the government sets the number, the higher the extraction (equal to the price of DR) per digital operator. While Rothkopf and Bazelon's proposal provides that additional rights would be released over time, policies to slow assignments would attract bids from those service providers demanding faster access to spectrum. "The proposal . . . would gradually make spectrum available on a property-rights-like basis," as opposed to all at once in a "big bang."[91]

The rights withheld are valuable to the degree that they improve the efficiency of wireless services; incremental revenues are captured by imposing a loss of efficiency. The magnitude of that social cost, ignored in Rothkopf and Bazelon's proposal, dominates plausible social gains from rent transfers to the public treasury. In fact, considering a base case with two markets, the first auction dollar raised exceeds one dollar in additional social cost.

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[90] Rothkopf & Bazelon, *supra* note 84 at 3–4.

[91] *Id.* at 3.

FIGURE 5: INCUMBENT BIDS FOR A NEW RIGHT

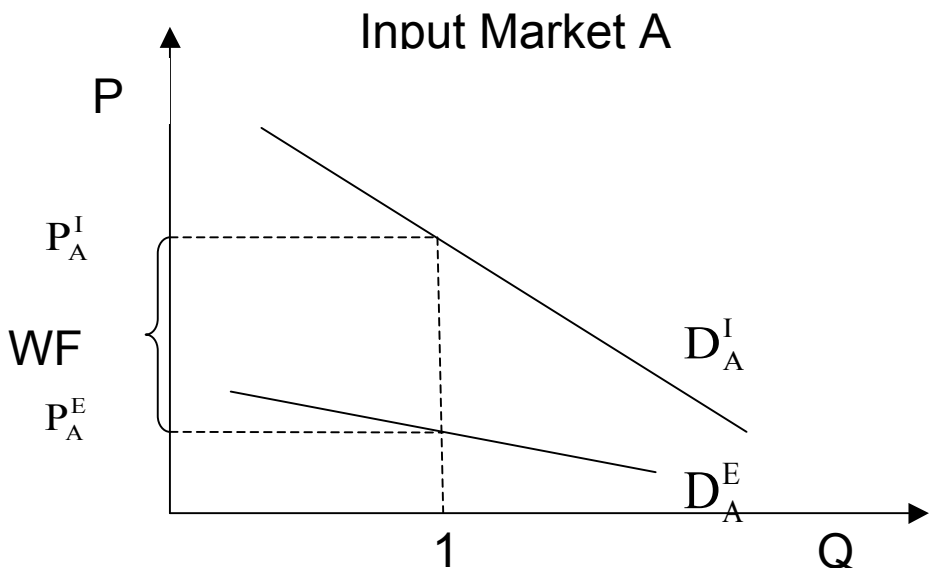
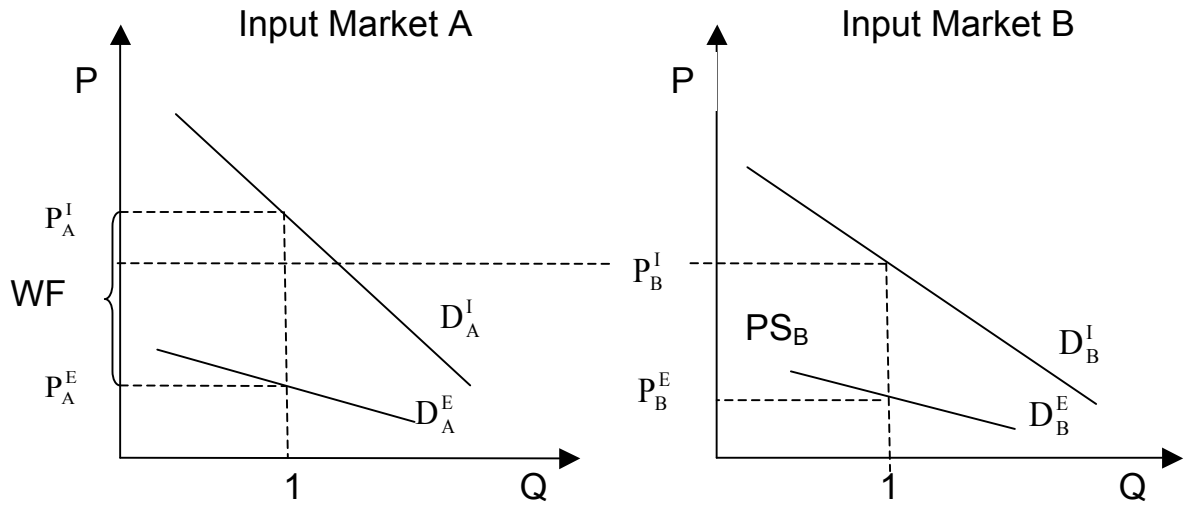


FIGURE 6: INTER-LICENSE AUCTIONS TO INCREASE REVENUE



In Figure 5, the basic problem is set forth. An incumbent in Market A, Firm A^I, seeks the right to switch from analog to digital technology. The policy issue is how to award that one new right.[92] The demand curve for such rights dominates the demand expressed by a potential

[92] This Article assumes that wireless license rights are generic and easily defined. Hence, a continuous demand for these rights is postulated. In fact, this is a very favorable assumption for Rothkopf and Bazelon's proposal. This

entrant, Firm A^E, given the substantial complementary investments previously sunk by the incumbent. Hence, if an auction were to award one additional right, the price would be bid to just about P_A^E. This means that rents equal to *WF* are retained, a windfall to the incumbent. Rothkopf and Bazelon's solution aims to transfer this private gain to the public by eliminating a license award in another market, Market B. This enables an auction between the incumbents in the rival markets, as pictured in Figure 6.

Now the incumbent in Market A is not bidding against the entrant in Market A, but against the incumbent in Market B. The incumbent in A must bid higher to gain the one new right, as competition for that right is made more intense. Instead of paying approximately P_A^E, the Firm A^E must pay about P_B^I. The windfall to A^I diminishes, and increased rents go to the government. Assuming that incremental revenue ($P_B^I - P_A^E$) equals one dollar, social savings of $0.33 are generated.

This is where the proposal concludes, omitting consideration of the loss imposed on Market B. It must be remembered that these losses are not the artifact of natural limitations with respect to demand, but are manufactured by policy makers imposing legal constraints on productive activities so as to leave some demand unsatisfied. But by excluding the marginal firm (or rights claimant), a social loss exceeding the revenue gained *from the first incremental revenue dollar* results, given that the loss on Firm B^I is greater than $0.33.

And this counts only the loss of producers' surplus. As explained above, consumers' surplus likely exceeds surplus extracted in license bids by at least one order of magnitude. The

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Article also assumes that the spectrum allocation process is unaffected, meaning that the same number of productive rights is released by regulators when incumbents receive windfalls as when they do not. This is, again, highly favorable to the proposal.

cost–benefit balance is overwhelmed, tipping against the withholding of spectrum rights over *any* interval. This demonstrates the loss of social efficiency that can result when license revenue extraction is the sole focus of economic analysis.

In the case where there are more than two markets and there are (again) fewer licenses auctioned than incumbents, the comparison is less clear. Suppose that $N - 1$ licenses will be auctioned so that just one incumbent will be deprived of the new right (i.e., $N - N_1 = 1$). The market with the lowest private valuation becomes the relevant margin, setting the license price. Calling A_i the "winning markets" and B the excluded one, as before, Rothkopf and Bazelon's mechanism implies the following necessary (but insufficient) condition for efficiency:

$$\frac{1}{3}\sum_{i=1}^{N-1}\left(P_B^1 - P_{A,i}^E\right) > P_B^1 + PV(CS_B)$$

where $PV(CS_B)$ represents the present value of consumer surplus lost in market B.

The inequality represents the case where the exclusion of market B is compensated by the social payoff of a less distorting revenue collection mechanism. It is not impossible for this inequality to be satisfied, but it is implausible. First, to escape the very high ratio of consumers' surplus to producers' surplus (shown above to exceed, perhaps, 100 to 1), many licenses must be auctioned for each license withheld; yet expanding rights issued reduces scarcity values and, therefore, revenues. In the limit, this converges with the liberal solution—maximize market competition, worry not about license extractions.

Second, Rothkopf and Bazelon's tactic consciously resists this optimum, creating artificial scarcity to puff up rents (PS) while imposing losses in output markets (PS + CS). Given that CS likely exceeds PS by an order of magnitude or more, this is likely to prove penny wise, pound foolish. Doubling PS—a hugely ambitious target—could be inefficient if CS were

reduced by just one percent (an outcome dictated by a CS to PS ratio greater than thirty-three, within the range of plausible estimates).

Third, institutional factors governing market dynamics strongly reinforce this pessimistic conclusion concerning efficiency gains through policy-imposed scarcity. There exists an infinite number of property rights to use radio spectrum in ways not previously specified in restrictive licenses that specify spectrum access with respect to technologies, services, and business models. Which rights would prove socially productive is generally unknown *ex ante*. Only when applicants petition for permission to change license terms do these new opportunities become visible to the regulator.

The policy of extracting rents from petitioners requesting permission to exploit new wireless property rights directly taxes the discovery process wherein wireless operators innovate in services, technologies, and business models. The object of the rights auction is to obtain full rent extraction; the direct effect of withholding the marginal applicant's rights is to sacrifice the social gains from that deployment entirely. Static losses are entirely a product of public policy, as there is no economic scarcity to be rationed among rival rights holders.

But the spectrum allocation dynamics are likely far more costly. Taxing efficiency-creating discoveries is perverse. Indeed, in intellectual property law, the government awards patents, copyrights, or trademarks to innovators *free of charge*, as an inducement to socially productive activity. Regulatory permission to deploy constitutes a barrier to entry; the more effective the system in appropriating innovators' gains, the lower the investment in such activity. Traditionally, spectrum-allocation rigidities have imposed high barriers to innovation, long the

subject of normative criticism by economists.[93] Incumbents would be protected by such a system, with competitive entry deterred via tax policy.

V. A Regulatory Optimum

This Part defines what an optimal regulatory policy might achieve, assuming that an FCC-type spectrum allocation regime exists.[94] It assumes that the regulator pursues policies to maximize social welfare and focus for ease of analysis on the market for wireless telephone service.[95] This goal can be summarized in three objectives: (1) allocate spectrum to promote the most efficient delivery of wireless services; (2) select a mechanism to assign licenses that maximizes social value; and (3) subject to these constraints, distribute licenses so as to maximize the present value of payments to the government.

The first goal concerns decisions made before licenses are assigned; indeed, it encompasses the procedure wherein licenses are created. Here, the regulator constructs a bundle

[93] *See* Gregory L. Rosston & Thomas W. Hazlett, Comments of 37 Concerned Economists, *In re* Promoting Efficient Use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets, WT Docket No. 00-230 (Feb. 7, 2001), http://www.brookings.edu/~/media/files/rc/reports/2001/02_economists_litan/02_economists_litan.pdf.

[94] Under an FCC-type regime, the government treats radio spectrum as state property and then makes case-by-case determinations as to how spectrum access rules will be crafted. The ostensible aim is to facilitate the efficient deployment of wireless services, and the basic rationale driving this structure is that there would be endemic chaos were there no central allocation mechanism in place. Coase demonstrated the weakness of the argument by showing that rules limiting spectrum access can be imposed as property ownership rules. Coase, *supra* note 41. The latter enable resource appropriation choices (including "spillovers") to be determined by asset owners under competitive conditions as opposed to government regulators. The liberalization of allocations for mobile phone licenses, where spectrum use choices tend to be broadly delegated to operators, follows Coase's normative suggestion. Observed results in mobile markets strongly support his intuition as to the efficiency of decentralized property rights. *See* Thomas W. Hazlett, *Optimal Abolition of FCC Spectrum Allocation*, 22 J. ECON. PERSP. 103 (2008); Hazlett et al., *supra* note 41. Some spectrum regimes—including those in Australia, New Zealand, Guatemala, and El Salvador—have gone further, instituting general liberalization by statute. Hazlett, *supra* note 51, at 582–86. Other countries—notably Norway, the UK, and the United States—have undertaken regulator-led reforms expanding market spectrum allocation. *See* Eric Bash et al., *Spectrum Liberalization: Approaches in Five Countries—Australia, New Zealand, Norway, the United Kingdom and the United States*, KB ENTERS. (Oct. 9, 2009), http://kbspectrum.com/wp-content/uploads/2009/10/KBE-Spectrum-Liberalization-FINAL.pdf.

[95] The path taken generalizes easily as spectrum rights are flexible and can be used to accommodate other wireless services as dictated by consumer demand.

of rights to assign to private parties, and establishes rules shaping industry structure and performance, fundamentally determining expected license rents.

A less concentrated market structure tends to increase price competition. Yet, scale and/or scope economies are pronounced in mobile markets, and dynamic (Schumpeterian) efficiencies may be improved where relatively efficient firms increase market share. Both fixed and variable costs tend to increase when the amount of spectrum assigned to a license is reduced, as happens when additional licenses share a given allocation of bandwidth. Given the costs and benefits of market concentration, this Article's hypothetical regulator designs policies to produce an optimal market structure.

The second goal is to assign licenses such that total welfare is maximized. As van Damme comments, this concept, "market efficiency," can differ from "value efficiency."[96] Because "bidders are guided by shareholder value and not by consumer surplus, . . . at best one can expect an auction to produce an allocation that is 'value efficient.'"[97] Market efficiency might, for example, be improved by auction rules that improve post-auction market structure.[98] Of course, limits on incumbents' bids also have costs, as vividly seen in the U.S. PCS DE preferences.

The third goal focuses on raising revenues for public use. This Article's assumptions isolate this process to one of pure rent transfer. In this context, higher revenues are unambiguously preferred to lower revenues. In actual policy-making, however, the assumption

[96] Van Damme, *supra* note 1, at 7.

[97] *Id.*

[98] See Richard J. Gilbert & David M.G. Newbery, *Preemptive Patenting and the Persistence of Monopoly*, 72 AM. ECON. REV. 514 (1982), for an excellent discussion of preemptive patenting, directly applicable here.

is a strong one. It is violated when incremental revenues are extracted by withholding productive rights.[99]

It is worth noting that license auctions are largely independent of the first goal,[100] are useful tools for the second, and are primary mechanisms used to achieve the third. These distinctions are important. This Article argues that the first goal is by far the most important one in terms of its impact on social welfare. This policy defines the amount of spectrum available in the market to provide services and heavily influences final market structure by, among other things, defining the number of available licenses.

The main task of auction design is to assign rights to the most efficient service providers. With market efficiency, this selection process does not conflict with the third goal: maximum revenues for the auctioneer. High revenues, which have been interpreted as a signal of a well-designed auction, are properly used as a metric when the policy design maximization is subject to the constraint of market-efficiency. And vice-versa: when the pursuit of high revenues conflicts with market-efficiency, the signal is likely to be highly misleading.

VI. Conclusion

> Assigning, or licensing, is the last step in the process of granting a right to use a part of the spectrum and has only limited consequences for economic efficiency in the context of the overall system.[101]

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[99] *See* discussion *infra* Part IV.

[100] It is commonly held that governments allocate more spectrum so that they can auction licenses and raise additional government revenue. *See, e.g.*, Eli Noam, *Spectrum Auctions: Yesterday's Heresy, Today's Orthodoxy, Tomorrow's Anachronism. Taking the Next Step to Open Spectrum Access*, 41 J.L. & ECON. 765 (1998). The evidence is decidedly mixed. Sometimes revenues appear as drivers, but governments sacrificed substantial rents for many decades by refusing to auction *any* wireless licenses. Hazlett, *supra* note 41. Were revenue a driver of additional allocations, regimes that use competitive bidding to make awards would allocate substantially more spectrum than nations that do not, *ceteris paribus*. While this Article holds that the evidence rejects this, further research on the political economy questions may add useful clarity.

[101] CONG. BUDGET OFFICE, AUCTIONING RADIO SPECTRUM LICENSES 3 (1992).

What really matters in spectrum allocation design? The evidence indicates that the answer is two-fold: *spectrum* and *competition* in final markets. This conclusion holds after adjusting for the social savings possible from efficient rent extraction via license auctions.

Yet, the economic analysis of wireless license auctions has focused on revenues extracted from bidders, seeing the "embarrassingly low revenue in the Netherlands," for example, as indicating a fiasco in public policy.[102] It might also be noted that the Dutch succeeded in making 355 MHz available for wireless phone operators, more than any other EU country. Alternatively, U.S. regulators then made only about 170 MHz of bandwidth available for use in wireless telephone markets, an outcome that merits little scholarly attention despite the "fiasco" it has produced in lost productivity.

Indeed, a decade-long loss of 30 MHz in the U.S. mobile market stemmed from the use of bidding credits in the 1995–1997 PCS auctions—a policy that was praised in the economics literature as a way to boost bid prices in license auctions. The policy did indeed succeed in raising winning bids. But the winners were not efficient providers. Moreover, the revenues went largely uncollected while the spectrum lay idle for years. These policy errors cost consumers in excess of $70 billion, more than all FCC license auction revenues in total, and thereby far out-stripping any social gains from this source of public rent extraction. Such collateral damage of the revenue-enhancement strategy has been unanticipated in policy analysis. It should not be.

Spectrum use is assumed to be exogenous to competitive bidding for licenses. If true, rents transferred to government in auctions would, by definition, have no social cost. But policy recommendations that include reserve prices, bidding credits for weak bidders, and a reduction in

[102] Wolfstetter, *The Swiss UMTS Spectrum Auction Flop*, *supra* note 1, at 6 n.8 (citing Paul Klemperer, *What Really Matters in Auction Design* (Nuffield Coll., Oxford Univ., Working Paper, 2000)).

the number of licenses issued incur expected social costs. These measures thereby breech the assumed line of demarcation. In addition, auction designers have intentionally or unintentionally imposed substantial delays in license assignments, depriving markets of valuable inputs.

This Article does not argue against the use of license auctions; just the reverse.[103] Auctions can be highly useful in eliminating the costs of secondary market recontracting, one of the reasons that random distribution of licenses (as was done by lottery for most cellular permits in the United States) is inefficient. Paul Milgrom's explanation of why it misuses the Coasian analysis to argue for random license assignments is well taken.[104] Yet this efficiency rationale itself conflicts with proposals commonly made, and with judging "successes" and "fiascoes" based on prices paid. Policies that alter market structure or the availability of spectrum inputs are not exogenous to spectrum allocation.

By increasing bandwidth allocated to market competitors, promoting rivalry among licensees, and expanding property rights granted to licensees, very large efficiency gains are possible. As shown in this Article's simulations or in empirical research concerning the importance of technological standards, competition liberalization of wireless markets is likely to be the key policy component driving substantial gains in social welfare.[105]

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[103] One of the authors of this paper argued publicly for FCC license auctions years before Congress enacted reform. *See* Thomas W. Hazlett, *Making Money Out of the Air*, N.Y. TIMES, Dec. 2, 1987, at A35; Thomas W. Hazlett, *Dial 'G' for Giveaway*, BARRON'S, June 4, 1990, at B12.

[104] MILGROM, *supra* note 36, at 20.

[105] *See* Neil Gandal et al., *Standards in Wireless Telephone Networks*, 27 TELECOMM. POL'Y 325 (2003); Peter Grindley et al., *Standards Wars: The Use of Standard Setting as a Means of Facilitating Cartels – Third Generation Wireless Telecommunications Standard Setting*, 3 INT'L J. COMM. L. & POL'Y, Summer 1999, no. 2.