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Spectrum Auctions Around the World:

An Assessment of International Experiences with Auction Restrictions

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Executive Summary

With new mobile services, applications and products coming to market at record speeds and consumer demand for wireless services soaring, the Federal Communications Commission (FCC) more than three years ago identified a looming spectrum shortage that could directly affect American wireless users and pose a significant threat to the continued expansion of mobile broadband. To address this challenge, the federal government has begun a concerted effort to reallocate up to 500 MHz of additional spectrum for commercial wireless service by 2020. According to the Commission, failure to meet this goal "could mean higher prices, poor service quality, an inability for the U.S. to compete internationally, depressed demand and, ultimately, a drag on innovation."[1]

As an initial step toward the 500 MHz goal, the Commission is currently targeting 120 MHz of broadcast spectrum for reallocation in an incentive auction that it hopes to hold in the second half of 2014. As the FCC goes about the work of determining the auction's design and rules, certain interests and potential auction participants are calling for discriminatory auction participation rules that would restrict the ability of some carriers to fully participate in the auction and/or favor the participation of other firms. The pursuit of public policy objectives through discriminatory auction participation rules has been attempted before—both in the US and around the world. Examples of policy objectives include encouraging new entry broadly, encouraging the entry of specific types of firms (e.g., small businesses, minority-owned businesses), and changing post auction market structure. This paper examines these experiences and evaluates the effectiveness of discriminatory auction rules in implementing public policy.

Our analysis shows that discriminatory participation rules do not work. Regulators have been unsuccessful in achieving stated policy goals through restrictive or preferential auction participation rules. Moreover, auction rules limiting the ability of certain carriers to participate fully in auctions, while favoring others, have interfered with the auction process, resulting in distorted prices, misallocation of spectrum, and adverse effects on consumers and competition in the post-auction market for wireless services. For example, in several instances discriminatory participation rules have delayed the deployment of new spectrum resources – in at least two cases by a decade.

We conclude that restrictions on participation in auctions are poor substitutes for other regulatory tools and enforcement measures available to the FCC and policymakers concerned with market structure and level of competition within the mobile market. Further, we find that repurposing already assigned spectrum and a dynamic secondary market for spectrum have had a more direct and lasting impact on enhancing the level and intensity of competition.

Key Findings:

There are several concrete examples in the history of public spectrum auctions where discriminatory participation rules adversely affected auction outcomes:

- In the 1996 U.S. auctions for Personal Communications Service (PCS) spectrum, restrictive spectrum set-asides rules and preferential rules, such as bidding credits and below-market financing terms, caused considerable harm to consumers.

[1] National Broadband Plan, Federal Communications Commission, Chapter 5, pp. 75, 77.

  - GWI PCS (later MetroPCS, and now part of T-Mobile), which received bidding credits through the FCC's Designated Entity program and favorable financing terms, was unable to satisfy its payment obligations to the FCC and filed for bankruptcy. The bankruptcy proceeding delayed the carrier's network build-out by several years. Courts ultimately reduced the company's required payment to the U.S. government from more than $1 billion to $166 million.
  - NextWave, which also participated in the PCS auctions under discriminatory auction rules, similarly sought bankruptcy protection because it was unable to meet its payment obligations. After years of legal battles, an FCC re-auction and subsequent return of its licenses, NextWave entered into a settlement, selling some of its PCS licenses to Cingular and Verizon Wireless and returning the rest to the FCC for auction. Deployment of services in the PCS spectrum initially won by NextWave was delayed nearly 10 years after the 1996 auction.
  - Urban PCS, another successful bidder in the PCS auction, experienced a fate similar to NextWave: bankruptcy and the sale of its licenses a decade after the PCS auction.
  - Several other companies, which also received bidding credits and other preferential financing terms, struggled to retain licenses. Disputes with the FCC over the payment of license fees and licensing terms delayed deployment of this spectrum as well.
  - Academic research shows at least $70 billion in consumer welfare losses resulting from discriminatory participation rules imposed in the 1996 U.S. PCS auctions. Hazlett et al. (2012).
- Spectrum caps imposed during the auctions of 3G spectrum in six European countries in 2000-2001 failed to produce a sustainable increase in the number of competitors. Changes in market structure proved fleeting, and none of the countries has more national carriers today than before the auctions.
- In Germany, where regulators restricted participation in the 3G auction through spectrum caps, two new entrants withdrew from the market without deploying the newly acquired spectrum. This spectrum lay fallow for a decade and was reassigned in the 2010 4G auctions.
- A spectrum cap was in place for the Canadian PCS auction in 2001, but the auction failed to enable the creation of a new national carrier, though new regional service was launched. After the cap was rescinded, a merger reduced the national carriers from four to three.
- A 2008 Canadian auction of AWS licenses set aside 40 of 90 MHz for new entrants. The discriminatory rule distorted prices for both the set-aside and unrestricted spectrum – Canadian AWS spectrum sold for three times the average price for AWS spectrum in the U.S. – and failed to attract national entrants. There has been little impact on the combined market share of the three national carriers.

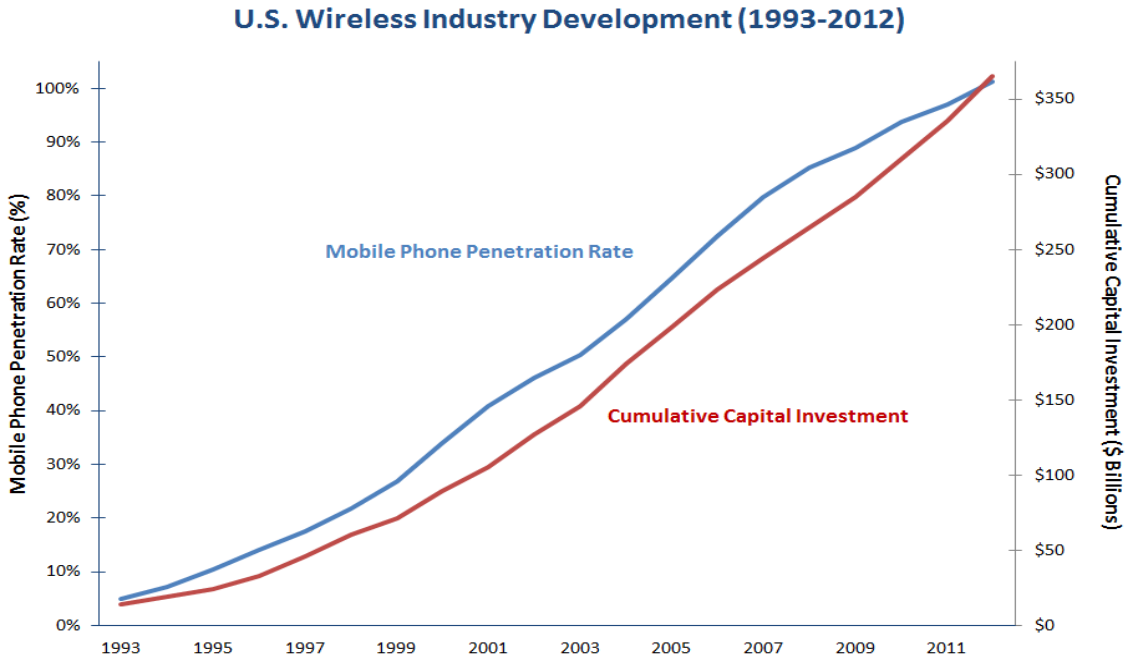
Regardless of the merits of the policy goals that were intended to be achieved with discriminatory auction participation rules, these policy tools have not been effective. Our research clearly demonstrates that these rules have failed to create the desired outcomes of stimulating sustainable market entry or otherwise altering the market structure. Instead, the restrictions have needlessly delayed spectrum deployments, subsidized certain bidders, and diminished auction revenues.

In addressing the spectrum crunch through a series of planned auctions, as experience shows, the FCC can enhance consumer welfare and competition in mobile services by avoiding the use of discriminatory auction participation rules. Other policy tools, separate from the auction, are more effective for the implementation of social and competition policy.

Table of Contents

I. Introduction

Wireless communications in the United States has experienced impressive demand growth and investment over the past 20 years. As the chart below and Table 1 illustrate, mobile subscriber connections have increased from 16 million in 1993 to 326.4 million in 2012 and cumulative capital investment in the wireless sector is approaching $365 billion. New services—such as mobile video, mobile commerce, and location-based services—have emerged to the benefit of consumers and the economy. More broadly, new mobile broadband technologies are altering the competitive landscape of the entire telecommunications sector, as wireless service providers begin to compete directly with wireline. Consider that at the end of 2012, 36.5 percent of all U.S. adults (approximately 86 million people) lived in a household that did not have a landline telephone but did have at least one wireless telephone.[2] To the extent consumers have competitive alternatives to wireline service such as wireless, the share of wireless households will only increase.[3]



Sources: Cellular Telecommunications Industry Association (CTIA).

[2] 38.2 percent of U.S. households only had wireless service at the end of 2012. Centers for Disease Control and Prevention (CDC), "Wireless Substitution: Early Release of Estimates from the National Health Interview Survey, July–December 2012." Released June 2013, available at http://www.cdc.gov/nchs/data/nhis/earlyrelease/wireless201306.pdf.

[3] For example, Verizon is now offering fixed wireless high-speed internet for $60/month.

The diffusion of wireless broadband throughout the US economy has produced significant economic benefits for consumers and the country writ large. In 2011, we examined the economic impacts of allocating an additional 500 MHz of spectrum to provide mobile broadband services. Our study concluded that the FCC's proposal could spur $125 billion in new capital spending, creating more than 500,000 jobs and $385 billion in additional Gross Domestic Product (GDP).[4] Studies of consumer welfare confirm the important role the wireless sector plays in the U.S. economy. For example, Hazlett et al. (2012) estimated that consumer surplus in the wireless sector was between $174 billion and $212 billion annually.[5]

Spectrum is an essential input for providing wireless services and operating wireless broadband networks, and there is widespread agreement—and significant concern in both the public and private sector—that the industry in the United States does not have access to adequate spectrum. The FCC has expressed concern that "[t]he growth of wireless broadband will be constrained if government does not make [additional] spectrum available. If the U.S. does not address this situation promptly, scarcity of mobile broadband could mean higher prices, poor service quality, an inability for the U.S. to compete internationally, depressed demand and, ultimately, a drag on innovation."[6] Indeed, in 2011 U.S. networks were operating at 80 percent of capacity, well above the global average rate of 65 percent.[7] As a remedy, the FCC and the Administration have proposed to make up to 500 MHz of additional spectrum available for mobile broadband use by 2020. The FCC is targeting 120 MHz of broadcast spectrum (roughly 20 channels or 40 percent of the total 294 MHz held by TV broadcasters in the aftermath of the digital television transition[8]) for reallocation through an auction that it hopes to conduct in the second half of 2014. The rulemaking process for those auctions is already underway.[9] The FCC also recently

[4] Sosa, David and Van Audenrode, Marc, "Private Sector Investment and Employment Impacts of Reassigning Spectrum to Mobile Broadband in the United States," Analysis Group, August 2011.
[5] Hazlett, Thomas W., Munoz, Roberto E. and Avanzini, Diego Bernardo, "What Really Matters in Spectrum Allocation Design," *Northwestern Journal of Technology and Intellectual Property* 10 (3), 2012. Surplus is measured in 2008 dollars.
[6] National Broadband Plan, Federal Communications Commission, Chapter 5, pp. 75, 77.
[7] Credit Suisse, "Global Telecom Equipment: Global Wireless Capex Survey," July 2011.
[8] FCC, "In the Matter of Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions: Notice of Proposed Rulemaking," WT Docket No. 12-268, October 2, 2012 (hereafter referred to as "Incentive Auction NPRM") ¶ 12; Macquarie (USA) Equities Research, "Incentive Auctions To Be Long & Arduous," September 11, 2012, p. 2.
[9] The Obama Administration is pursuing other efforts, beyond the broadcast incentive auctions to provide additional spectrum for wireless services. Thirty MHz of spectrum have been freed up for wireless services by revisions to the rules for Wireless Communications Services (WCS) spectrum. In March, 2013 the FCC announced a

announced a plan to auction spectrum in the AWS-2 band and launched a rulemaking proceeding to adopt service rules for spectrum in the AWS-3 band, including spectrum currently used by the Federal government at 1695-1710 MHz and 1755-1780 MHz.[10] In a separate but related rulemaking, the FCC is looking at whether to limit the amount of spectrum any one carrier can hold in a market. Capping the amount of spectrum one can obtain as a general matter will obviously impact a company's level of participation in future spectrum auctions. As discussed later in this paper, experience suggests that constraints that limit spectrum acquisition in an auction or restrict participation by some bidders will mean a less efficient auction with lower proceeds, without an offsetting benefit of inducing new entry or enhancing competition.

II. State of the Market: A Refresher on 1993 – 2013

As the FCC considers the rules for the coming incentive auctions, it is important to take into account how the market has changed since Congress first authorized spectrum auctions in 1993. Voice and paging were the only commercial applications for mobile communications, two-way text messaging had not yet been widely introduced, nor had mobile broadband services.[11] The FCC had licensed no more than two service providers in most markets, and only six percent of the US population had a mobile phone. Today, the penetration rate exceeds 100 percent, as many consumers have more than

system to allow the use of unused television spectrum, "TV white space," by wireless hotspots to extend their coverage and ranges. The FCC has also proposed a re-evaluation of the government use of spectrum with a view to consolidating and freeing up spectrum that could be used by the wireless sector rather than by government. FCC, "In the Matter of Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993 Annual Report and Analysis of Competitive Market Conditions With Respect to Mobile Wireless, Including Commercial Mobile Services: Sixteenth Report," FCC 11-186, March 21, 2013 (hereafter referred to as "16th Competition Report"), p. 77; FierceWireless, "FCC's Genachowski: We're on track to free up 300 MHz of spectrum by 2015," October 5, 2012, available at http://www.fiercewireless.com/story/fccs-genachowski-were-track-free-300-mhz-spectrum-2015/2012-10-05; FCC Public Notice, "Office of Engineering and Technology Authorizes TV White Space Database Administrators to Provide Service to Unlicensed Devices Operating on Unused TV Spectrum Nationwide," ET Docket No. 04-186, March 1, 2013.

[10] National Broadband Plan, Federal Communications Commission, Chapter 5, p. 86; FCC, "Auction of H Block Licenses in the 1915-1920 MHz and 1995-2000 MHz Bands; Comment Sought on Competitive Bidding Procedures for Auction 96," AU Docket No. 13-178, July 15, 2013, p. 2; FCC, "In the Matter of Amendment of the Commission's Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz Bands," FCC 13-102, July 23, 2013, p. 3.

[11] The first commercial text message was sent in 1992. CTIA, "The U.S. Wireless Industry Overview," April 25, 2012.

one mobile device. Reasons for the near universal adoption of mobile telephony include the increasing diversity in available mobile devices, growth in services offered, and reduction in the price of service.[12]

As the Commission reported in March 2013, wireless networks cover nearly the entire US population. 97.2% of consumers have a choice between three or more service providers, and 80.4% of consumers can choose among at least five.[13] The Commission's description of market participants in its 16th Competition Report further illustrates how dynamic the US market for mobile voice and data services has become. As the agency reported, there are four national carriers, several regional carriers and "approximately 95 smaller, facilities-based providers in the continental United States, Alaska, and Hawaii as of October 2012" offering mobile voice and data services.[14] In addition, there are many Mobile Virtual Network Operators (MVNOs) and a number of other companies offering mobile and fixed data services. These companies offer a vast array of services, and US consumers have a wide choice of handsets from 23 different manufacturers.[15] Moreover, US service pricing has fallen considerably over the past 20 years. The Commission reported that between 1993 and 2011, average revenue per voice minute fell from 43.9 cents to 4.7 cents in nominal terms, a decline of 11.7% per year on average.[16] As prices have fallen, demand has increased, rising from 140 voice minutes per month, on average, in 1993, to 769 minutes per month in 2007, and 615 minutes per month in 2011, a compound annual growth of 8.6%.[17] Demand for SMS messaging and data has increased even more dramatically in recent years, reflecting the shift from voice traffic to data traffic.[18] These important indicators suggest today's market for wireless is vastly different from the one that existed in 1993, and is thriving with fierce competition, constant innovation and tremendous consumer benefits.

[12] See Table 1, below, for details.
[13] 16th Competition Report, p. 6.
[14] 16th Competition Report, p. 38.
[15] 16th Competition Report, pp. 216, 217.
[16] 16th Competition Report, p. 178.
[17] 16th Competition Report, p. 178.
[18] 16th Competition Report, pp. 173-175.

Table 1: U.S. Wireless Industry Development (1993 vs. 2012)

Year	1993*	2012
Wireless Subscriber Connections (millions)	16.0	326.4
Wireless Penetration of Population (%)	6.2	101.0
Wireless-Only Households (%)	n/a	35.8
Total 12-Month Wireless Revenue ($ billions)	10.9	185.0
Cumulative Capital Investment ($ billions)	14.0	365.4
Cell Sites (thousands)	12.8	301.8
Population Coverage (millions)	75.9	322.8
% Population Coverage (%)	29.4	99.9
% Population Served by 3 or More Providers (%)	0.0	97.2
% Population Served by 5 or More Providers (%)	0.0	80.4

* Population coverage of 1993 is assumed to be equal to the population coverage of McCaw, the nation's largest provider of cellular services in 1993.
Sources: CTIA; FCC. See Appendices for additional details and sources.

These market statistics suggest that the FCC has satisfied a key objective of U.S. spectrum policy, which is to encourage competition in the provision of wireless services. Consumers have reaped extraordinary benefits from the rapidly growing and dynamic wireless industry that today is central to the US economy and consumers' daily lives.

III. Proposals Being Considered in the Incentive Auction Proceeding

It is hoped that up to 120MHz of spectrum (roughly 20 channels or 40 percent of the total 294 MHz held by TV broadcasters in the wake of the digital television transition) will be voluntarily sold by broadcasters during the first step of the incentive auction, the "reverse auction."[19] The FCC would then "repack" the remaining broadcasters, thus clearing a swathe of spectrum that would be organized into a mobile-optimized band plan (step two). The licenses in that band plan would then be sold to wireless providers during the "forward auction" (step three). The FCC has laid out an ambitious agenda to finalize the underlying rulemaking in 2013 and conduct the auction by the end of 2014. The gross

[19] Incentive Auction NPRM, ¶ 12; Macquarie (USA) Equities Research, "Incentive auctions to be long & arduous," September 11, 2012, p. 2.

revenue from this auction has been projected as high as $36 billion, of which Congress has designated more than $7 billion to create a nationwide broadband public safety network.[20]

In the incentive auction proceeding, the FCC has asked for comments on a range of alternative proposals that, if adopted, would restrict the ability of some wireless service providers to participate fully in the auction. The Commission's stated motivation is "to avoid excessive concentration of licenses."[21] The restrictive policy alternatives being considered include:

- Prohibiting any single participant in the auction from acquiring more than a certain fraction of the spectrum being auctioned in a given geographic region.
- Variations on a cap on licenses acquired at auction with thresholds that differ in urban and rural areas.
- A cap on license holdings that would "recognize the different characteristics of different spectrum bands."
- A soft cap on holdings in the 600 MHz band "that would allow a licensee to acquire additional 600 MHz spectrum above that threshold, so long as the licensee agrees to comply with certain conditions, such as spectrum sharing through roaming and/or resale obligations, infrastructure sharing, or accelerated buildout requirements."[22]

The assumption behind restrictions of this sort is that consumers would be better off if less of the newly available spectrum was acquired by certain incumbents. For nearly 20 years, the FCC has used auctions as the principal tool for the assignment of spectrum licenses, developing specific rules for each auction and imposing a variety of discriminatory participation rules, including restrictions on the ability of certain incumbents to participate and rules favoring other firms (incumbents and possible entrants). In the following sections we explore the utilization of such policy tools in previous auctions, both in the US and abroad, to gauge the impact of discriminatory auction participation rules such as spectrum caps and set-asides on auction efficiency, market entry and competition. Our research suggests that consumers have in fact been harmed by the types of discriminatory participation rules that have been proposed in the current incentive auction.

[20] Coleman Bazelon, "Expected Receipts from Proposed Spectrum Auctions," (2011), The Brattle Group, p. 19 available at http://www.brattle.com/_documents/UploadLibrary/Upload964.pdf; NTIA, "Public Safety," available at http://www.ntia.doc.gov/category/public-safety.
[21] Incentive Auction NPRM, ¶ 384.
[22] Incentive Auction NPRM, ¶ 384.

IV. Discriminatory Participation Rules in U.S. PCS Spectrum Auctions

In the early 1990s, the FCC allocated 120 MHz of PCS spectrum to wireless communications.[23] The Commission deployed two auction tools in the PCS spectrum auctions with the intention of meeting both social and competition goals. First, the agency was mandated by Congress to use auctions as a way to stimulate small business involvement in the wireless sector. The agency "set aside" certain licenses for "entrepreneurs" (smaller businesses meeting certain asset and revenue limits), and offered "bidding credits" and "installment payment financing" to small and very small businesses (who met certain revenue limits) to accomplish this.[24] These rules were adopted as a way to address concerns about post-auction competition among providers.[25]

Following the initial round of license assignments within the PCS auctions in 1994 and 1995, the wireless industry grew rapidly through the entry of facilities-based providers. Companies such as Sprint[26], Leap[27], MetroPCS[28] and VoiceStream Wireless[29] entered the US wireless market by acquiring spectrum in the PCS auctions. However, several of the companies that relied most heavily on

[23] The FCC initially allocated 120 MHz of licensed spectrum to PCS. In 2004, the Commission added an additional 10 MHz of licensed spectrum to the PCS band.

[24] Set asides reserve blocks of spectrum so that only certain auction participants can bid on it. Auction participants with bidding credits are awarded a discount off their winning bids.

[25] Separate from the PCS auction rules, in 1994 the FCC also adopted a cap on the amount of spectrum a company could acquire in any one market. The spectrum cap was in effect until 2003.

[26] In March 1995, Sprint Spectrum and its affiliates won the rights to PCS licenses in 30 major trading areas at a cost of $2.2 billion. Sprint Form 10-K405, filed March 12, 1996, p. 4.

[27] DCR Communications and Chase Telecommunications won licenses in the first C block PCS auction. DCR Communications changed its name to Pocket Communications in May 1996. Leap Wireless and Pocket Communications formed a joint venture in 1999. In March 2000, Leap acquired licenses of Chase Telecommunications Holdings. FCC Auction Data; Bloomberg Businessweek, Company Overview of Pocket Communications; Leap Wireless Press Release, "Leap Wireless and Pocket Communications Complete Formation of Joint Venture to Provide Expanded South Texas Region Mobile Communications Services," October 1, 2010; Leap Wireless International 10-K filed March 29, 2002, p. 128.

[28] GWI PCS (winner of licenses in first C block PCS auction) changed its name to Metro PCS Wireless in 1999. Metro PCS was acquired by T-Mobile in 2013. Bloomberg Businessweek, Company Overview of Company Overview of MetroPCS Wireless, Inc; T-Mobile News Release, "T-Mobile and MetroPCS Combination Complete – Wireless Revolution Just Beginning," May 1, 2013, available at http://newsroom.t-mobile.com/phoenix.zhtml?c=251624&p=irol-newsArticle&ID=1813495&highlight=.

[29] In 1999, Voicestream, which won PCS licenses in the C block, merged with Omnipoint. Omnipoint was awarded a PCS license for the New York City market under the FCC's Pioneer's Performance Program. Voicestream was acquired by T-Mobile in 2000. FCC Auction Data; New York Times, "Voicestream and Omnipoint Announce $3 Billion Merger," June 24, 1999; FCC, "In the Matter of Implementation of Section 6002(B) of the Omnibus Budget Reconciliation Act of 1993 Annual Report and Analysis of Competitive Market Conditions with Respect to Commercial Mobile Services," August 18, 1995, ¶ 4; The New York Times, "Deutsche Telekom to Pay $50 Billion For U.S. Company," July 24, 2000.

discriminatory rules during the auction were unable to meet even the generous financing terms offered by the FCC, and fell into financial distress.

For example, MetroPCS participated in the FCC's C-Block set-aside auctions of broadband PCS spectrum licenses and was declared the high bidder on licenses in the Miami, Atlanta, Sacramento and San Francisco metropolitan areas in May 1996, promising to pay more than $1 billion (net of bidding credits) for these licenses through the FCC's installment financing. The FCC issued the licenses to MetroPCS in January 1997. MetroPCS, however, was unable to obtain the financing necessary to service its debt to the FCC and build its networks. In 1997, the company filed for bankruptcy protection. The bankruptcy court ruled that the FCC made a fraudulent conveyance and reduced the amount of the FCC's loan secured by the licenses to $166 million.[30] As a result of the bankruptcy court proceedings, after crediting the $106 million MetroPCS had paid to the FCC as down payments for its licenses, the remaining amount MetroPCS owed to the FCC was reduced to $60 million. In September 1998, the bankruptcy court confirmed MetroPCS' plan of reorganization and it emerged from bankruptcy in October 1998. The bankruptcy court's order was affirmed in October 2000 and a subsequent appeal by the FCC was denied in 2001. MetroPCS launched service in 2002.[31] The company's financial distress, related to the auction, delayed by several years its ability to deploy the PCS spectrum it acquired. Ultimately, MetroPCS was sold to T-Mobile.

NextWave, which also took advantage of the agency's set aside rules in the C Block auction along with bidding credits and installment payment financing, bid $4.2 billion (net of credits) for PCS spectrum. In 1998, the company sought bankruptcy protection to restructure payment of its FCC license debt. The FCC declared NextWave in default, reclaimed the licenses NextWave had won at auction, and reauctioned them in 2001 in Auction 35. During several years of litigation over the company's licenses, a federal appeals court ruled that the FCC violated bankruptcy law when it repossessed NextWave's licenses and, in 2003, the Supreme Court upheld the federal appeals court decision. The FCC and NextWave negotiated a settlement in 2004 in which NextWave kept some of the PCS licenses and returned others to the agency. In 2003, Cingular Wireless and NextWave announced an agreement for

[30] Metro PCS 10-K filed May 12, 2006, p. 6.
[31] Metro PCS 10-K filed May 12, 2006.

Cingular to purchase spectrum from NextWave for $1.4 billion. In late 2004, NextWave announced that it had sold all of the remaining PCS licenses it held to Verizon Wireless for $3 billion.[32]

In May 1996, Urban Communicators PCS ("Urban Comm") was the successful bidder for ten C-Block PCS licenses. In exchange for the licenses, Urban Comm paid 10 percent of its net winning bids up front and agreed to pay the remaining $67.2 million in installments over ten years, with interest calculated at 6.5 percent. On October 28, 1998, the day before its second installment payment on the licenses was due, Urban Comm filed for bankruptcy. The FCC immediately reclaimed Urban Comm's licenses, the company's only assets at the time of bankruptcy. In September 2003, the FCC restored the licenses to Urban Comm, following the Supreme Court's decision in the NextWave case. Ultimately, Urban Comm negotiated the sale of its PCS licenses out of bankruptcy. The buyers were Verizon Wireless and Leap Wireless. The last of the licenses sales closed in August 2006.[33]

Using auctions to allocate PCS spectrum in the mid-1990s benefited consumers and competition by providing existing carriers with additional spectrum and new competitors with the spectrum required to enter the nascent wireless market and offer service. However, discriminatory participation rules were ineffective in achieving the FCC's social policy goals with respect to small business participation. As the CBO noted in a 2005 study, "the preferences adopted by the FCC in the PCS auctions, particularly… [the] spectrum set aside for small businesses…, did not ultimately result in widespread or long-term participation by small businesses in the PCS market."[34] Moreover, unanticipated consequences associated with the restrictions on participation included delays of between three and ten years in the deployment of as much as 20 percent of this spectrum and substantial harm to consumer welfare.[35] As

[32] FCC, "In the Matter of Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993 Annual Report and Analysis of Competitive Market Conditions With Respect to Mobile Commercial Mobile Services: Ninth Report," FCC 04-216, September 28, 2004 (hereafter referred to as "9th Competition Report"), ¶¶ 28, 31; FCC, "In the Matter of Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993 Annual Report and Analysis of Competitive Market Conditions with Respect to Commercial Mobile Services: Tenth Report," FCC 05-173, September 30, 2005, ¶62.

[33] "Urban Communicators PCS Limited Partnership v. Gabriel Capital, LP," Opinion, July 1, 2012, available at http://chapter11cases.com/urban-communicators-pcs-limited-partnership-v-gabriel-capital-lp-2/; RCRWireless, "Leap acquires Urban Comm Carolina spectrum for $31.8 million," March 14, 2006, available at http://www.rcrwireless.com/article/20060314/sub/leap-acquires-urban-comm-carolina-spectrum-for-31-8-million/.

[34] Congressional Budget Office, "Small Bidders in License Auctions for Wireless Personal Communications Services," October 2005, p. 1.

[35] Hazlett, et. al. (2012).

the CBO observed, "economically valuable spectrum that could have been in service lay fallow for almost a decade in some geographic markets."[36]

Such delay slows competition and innovation. Over the years economists have estimated the loss in consumer welfare from delays in spectrum licensing. Hazlett et. al. (2012) estimated that the loss in consumer welfare attributable to the delay in assigning the NextWave PCS licenses was approximately $70 billion.[37] Thus any restriction in the provision of services due to spectrum constraints can be expected to cause substantial consumer harm.

Given the urgency of expanding the spectrum supply to keep up with consumer demand for services and the expansion of higher-capability 4G services, delays in moving more spectrum into the hands of wireless broadband providers now would be particularly troubling given the role of wireless in American life in 2013. As wireless services become more central to consumers' lifestyles and business productivity, the FCC should be concerned about any policies that might reduce the ability of the industry to address rising demand. Such policies, including discriminatory auction participation rules, are likely to have an even greater negative effect on economic growth and consumer welfare as wireless continues to grow in importance.

V. Use of Spectrum Caps and Bidder Participation Restrictions around the World

Regulators around the world have unsuccessfully attempted to shape market structure through discriminatory auction rules. In the 2000-2001 time period, when European countries were assigning spectrum for 3G wireless, one policy objective of several European regulators was to change the market structure of domestic wireless industries by increasing the number of service providers.[38] Regulators used discriminatory auction participation rules, including set asides and license acquisition limits, in an attempt to reach this goal. Canada has also sought to shape its market structure by applying a spectrum cap and set asides to companies participating in spectrum auctions. As we discuss below, in a few

[36] Congressional Budget Office, "Small Bidders in License Auctions for Wireless Personal Communications Services," October 2005, p. 1.
[37] Hazlett, et. al. (2012) citing Hazlett & Munoz, "A Welfare Analysis of Spectrum Allocation Policies," *RAND Journal of Economics* Vol. 40, No. 3 (2009).
[38] Gruber, H., "The Economics of Mobile Telecommunications," Cambridge University Press, 2005, p. 278. See also Cramton, P., E. Kwerel, et al. "Using Spectrum Auctions to Enhance Competition in Wireless Services," *Journal of Law and Economics* 54(4), 2011.

instances, countries were initially successful in attracting new participants through auctions with restrictive participation rules; however, a decade later, the number of competitors in these countries is unchanged relative to pre-auction levels. The European and Canadian experiences illustrate the distortionary consequences of restrictive participation rules that do not accomplish the regulator's policy goals.

Our discussion is limited to those auctions where participation restrictions were imposed and the marketplace has had time to react and adjust to results of the auction through events such as bankruptcies and secondary market transactions, limiting our coverage of European auctions to those that occurred at least five years ago. The auctions discussed in this paper fall into two categories: 3G auctions in the years 2000 and 2001, and the Canadian AWS auctions. Several European countries auctioned spectrum licenses for "third generation" (3G) mobile telecommunications in the 2.1 GHz band in 2000 and 2001, including the United Kingdom, Germany and Austria[39]. In 2001, Canada auctioned PCS spectrum for 3G mobile telecoms.[40]

A. UK 3G/UMTS Auction

In March 2000, the UK auctioned two larger (2x15MHz paired) and three smaller (2x10MHz paired) nationwide 3G licenses in addition to four blocks of unpaired (5MHz) licenses.[41] Prior to the auction there were four major facilities-based providers in the wireless market: Vodafone, BT Cellnet, One2One, and Orange. One policy objective of the UK auction was to encourage additional entry by other facilities-based providers.[42] To that end, the auction rules included a set aside. Bidding on one of the large licenses was restricted to new entrants. Additionally, no bidder could acquire more than one

[39] We do not discuss the ongoing auctions for 4G spectrum in several European countries.
[40] The license structure in Europe differed from the regional approach used in the U.S. and Canada; the European countries offered national licenses.
[41] Ofcom, "The Communications Market 2006," August 10, 2006, p. 45; DBS Securities, "(HK) Hutchison-TIW wins '3G' licence in the UK," April 28, 2000, p. 1.
[42] Department of Trade and Industry Information Note, "Hewitt Confirms Start Date For 3G Mobile Licence Auction," February 18, 2000, available at http://www.ofcom.org.uk/static/archive/spectrumauctions/press/200221.htm; Department of Trade and Industry Information Note, "Byers Announces 3G Mobile License Winners," April 27, 2000, available at http://www.ofcom.org.uk/static/archive/ra/publication/press/2000/27apr00.htm.

license.[43] The sale of spectrum on a secondary market basis was prohibited at the time of the auction, rendering the 3G licenses non-tradable.[44]

All five licenses were sold, raising £22.47bn ($35.4 billion). TIW (backed by Hutchison and operating under brand name "3UK") won the new entrant set aside license and the four existing market participants – BT Cellnet, Orange, One2One and Vodafone – won one license each.[45] Research suggests that the strongest new entrant and the two smaller existing market participants valued licenses with less bandwidth almost as much as ones with greater bandwidth, but the two larger existing market participants valued greater bandwidth licenses considerably more than lesser bandwidth licenses.[46] This implies that less revenue was obtained for the set-aside licenses than would have been the case if there had not been set-asides, and that the auction resulted in a less efficient allocation of spectrum because of the set-asides. The set-aside license was sold at a discount.[47]

In the decade after the auction, new entrant 3UK and several existing market participants have struggled competitively. 3UK has experienced significant difficulty in the UK market and did not generate a profit until 2010.[48] Recently, there has been consolidation in the UK market. Two of the four existing market participants in 2000 (T-Mobile and Orange) merged in 2010, creating Everything Everywhere. In approving the merger, the European Commission concluded that the market would be competitive post-transaction with the remaining facilities-based competitors and several MVNO competitors. In the current market structure there are three major players – Vodafone, O2, Everything Everywhere – and the 3G entrant 3UK has a small market share (five to ten percent).[49] The remaining carriers are striking network-sharing agreements and the network market is consolidating down to just two network infrastructure groupings (EE and H3G in one group and Vodafone and O2 in the other

[43] The license terms also were technology specific, restricting use to the UMTS 3G mobile phone standard. There were no restrictions on the size of the entities who could bid on the set aside. Crandall R and Ingraham A, "The Adverse Economic Effects of Spectrum Set-Asides," *Canadian Journal of Law & Technology,* Vol. 6, November 2007.
[44] In 2011, Ofcom eliminated the prohibition on trading 3G licenses.
[45] BBC News, "UK mobile phone auction nets billions," 27 April 2000.
[46] Klemperer, P., "How (Not) to Run Auctions: The European 3G Telecom Auctions," *European Economic Review*, 46 (4), 2002 pp. 829-845.
[47] For paired spectrum, set-aside spectrum was sold at £4.9 per MHz-pop whereas the remaining spectrum was sold at prices between £6.7 per MHz-pop and £6.8 per MHz-pop. Crandall & Ingraham (2007).
[48] BBC News, "Li Ka-shing's Hutchison finally sees 3G profits," March 29, 2011.
[49] European Commission, Case No COMP/M.5650 - T-MOBILE/ ORANGE, pp. 9, 13, 14, 15, 16.

group).[50] It is impossible to say how the market would have looked in 2012 if a 3G license had not been set aside for a new entrant in the 2000 auction, but less than 10 years after 3UK started offering service, the number of competitors, at four, is the same as before the auction.

B. German 3G/UMTS Auction

Germany held major wireless spectrum auctions in July and August 2000. Prior to the auction in 2000, there were four players in the market: T-Mobile, Mannesmann Mobilfunk (now Vodafone), E-Plus, and Viag Interkom. The German government auctioned national licenses for 120 MHz of paired spectrum in 2 x 5 MHz blocks in a first phase and 25 MHz of unpaired spectrum (1 x 5 MHz blocks) in a second phase. The German regulator imposed a spectrum cap on auction participants: in the first phase of the auction, participants had to bid on a minimum of 20 MHz (2 x 10 MHz) of paired spectrum, but could not acquire more than 30 MHz (2 x 15 MHz).[51] This cap meant that the range of successful auction participants would be between 4 and 6 firms. Participation in the second phase of the auction, for unpaired spectrum, was limited to bidders that had won licenses for paired spectrum in the first stage. The only eligibility restriction was a minimum measure of financial strength.

Germany's 3G spectrum auction ended in August 2000, with six winners (the four existing market participants plus two new entrants). Each bidder was awarded 20 MHz of paired spectrum.[52] The new firms attempting to enter the German mobile market through the 3G auctions were MobilCom (owned by France Telecom) and Group 3G (trade name Quam, a consortium between Spain's Telefonica and Finland's Sonera).[53] However, neither of these firms deployed the 3G spectrum they had won at auction. In fact, their failure was quite rapid and spectacular. In mid-2002, Group 3G announced that it

[50] The Register, "O2, Vodafone allowed to hop onto each other's towers," October 1, 2012, available at http://www.theregister.co.uk/2012/10/01/o2_voda/.
[51] BK-1b-98/005 - 1, "Ruling of 18 February 2000 by the President's Chamber on the Determinations and Rules for the Award of Licences for the Universal Mobile Telecommunications System (UMTS)/International Mobile Telecommunications-2000 (IMT-2000)," (Translation), pp. 3, 8.
[52] In the second phase of the auction 5 of the 6 winning bidders in the first round won a block of un-paired spectrum. The un-paired spectrum sold at a substantial discount to the paired spectrum. Receipts for the unpaired spectrum were approximately 0.6% of the receipts for the paired spectrum. Grimm, V., Riedel, F., and Wolfstetter, E., "The Third Generation (UMTS) Spectrum Auction in Germany," p. 10.
[53] Grimm, V., Riedel, F., and Wolfstetter, E., "The Third Generation (UMTS) Spectrum Auction in Germany," pp. 6-7.

would go out of business.[54] In 2003, Mobilcom returned its 3G license to the German regulator.[55] The 3G auctions failed to alter market structure; the German market has continued to be supplied by four network operators.

The disposition of the entrants' licenses in the German 3G auction was similar to that of the PCS C-block in the US. That is, the spectrum won by the new entrants lay fallow for nearly a decade following the 3G auction. It was not reassigned until the German government conducted an auction of 4G spectrum in 2010.[56] This fallow spectrum represented one-third of all paired 3G spectrum offered in 2000, resulting in a considerable loss to consumers of access to improved service. Although the spectrum cap imposed by the German regulator influenced the number of winning bidders, the regulator was unable to affect market structure and the distortions introduced by the cap and other aspects of auction design restricted the availability of spectrum for consumer use.

C. Austrian 3G/UMTS Auction

The Austrian auction of 3G spectrum in late 2000 followed close on the heels of the German auction and was structured very similarly, with the stated intention of promoting competition by increasing the number of licensees.[57] At the time of the auction there were four service providers: Mobilkom Austria, Connect Austria, Max.mobil (later rebranded as T-Mobile), and Tele.ring. The Austrian regulator offered twelve 10 MHz blocks of paired spectrum (2 x 5 MHz), subject to a cap. The blocks could be configured as either four 30 MHz licenses or six 20 MHz licenses. This cap meant that the range of successful auction participants would be between 4 and 6 firms. In the second phase of the auction, the Austrian regulator offered 25 MHz of unpaired spectrum (1 x 5 MHz blocks).

[54] Light Reading Mobile, "German 3G Player Folds," July 24, 2002, available at http://www.lightreading.com/german-3g-player-folds/240040189.
[55] German Regulatory Authority for Telecommunications and Posts, "Annual Report 2004." Mobilcom continued to operate as a reseller of wireless service (mobile virtual network operator or MVNO), but failed in its efforts to enter the market as a network operator (facilities-based service provider). Prepaid MVNO, "German MVNO mobilcom-debitel shops show videos on Mobile devices," April 25, 2013, available at http://www.prepaidmvno.com/2013/04/25/german-mvno-mobilcom-debitel-shops-show-videos-on-mobile-devices/.
[56] BK1a-09/002, Bundesnetzagentur, President's Chamber Decision of 12 October 2009 (Translation), pp. 18-19.
[57] Rundfunk und Telekom Regulierungs GmbH (RTR), "Telecommunications Report 2000," Section 2.1.2.1, Assignment of UMTS/IMT-2000 licences.

Only six firms competed in the auction: the four existing market participants and two entrants - Telefonica and Hutchinson 3G. [58] The auction concluded after 16 rounds with each participant winning a 20 MHz license.[59] The auction was widely viewed as a failure because the receipts were less than one-sixth of the per capita revenue raised in the UK and German UMTS auctions held earlier that same year.[60] The average sale price per 20 MHz paired license was €117 million, only 17% above the reserve price of €100 million.[61]

In addition to the failure of the auction to generate expected receipts, Austrian authorities were not successful in their effort to increase the number of competitors beyond four carriers. One of the new entrants, Telefonica, exited the market in 2003, selling its license to Mobilkom and T-Mobile.[62] Although the other new entrant, Hutchinson 3G, did develop the spectrum it won at auction and is offering service in Austria, there have been further changes in the market structure to reduce the number of competitors. In 2005, Tele.ring was acquired by T-Mobile[63] and in 2012 Hutchinson 3G acquired the owner of the Connect Austria assets (then owned by Orange).[64] Thus twelve years after the UMTS auction, the number of carriers operating in Austria has fallen to three.

D. Lessons from the European 3G Auctions

As noted above, the spectrum caps and set-asides used in the UK, Germany and Austria 3G auctions illustrate how European regulators were unsuccessful in their attempts to alter the market structure through spectrum auctions. For Germany and Austria, the policy failure occurred within a

[58] Gruber (2005), pp. 256-257.
[59] In contrast, the German 3G auction lasted 173 rounds. Gruber (2005), p. 254.
[60] Klemperer (2002), pp. 829-845.
[61] The Austrian regulator set the reserve price at €50 million per 10 MHz block of paired spectrum. Rundfunk und Telekom Regulierungs GmbH (RTR), "Telecommunications Report 2000," Section 2.1.2.1, Assignment of UMTS/IMT-2000 licences.
[62] Telefonica Press Release, "Telefónica Móviles and mobilkom austria reach agreement on the sale of 3G Mobile," December 23, 2003, available at http://www.telefonica.com/en/shareholders_investors/pdf/hr231203.pdf; Telegeography, "T-Mobile buys extra 3G bandwidth," April 5, 2004, available at http://www.telegeography.com/products/commsupdate/articles/2004/04/05/t-mobile-buys-extra-3g-bandwidth/.
[63] New York Times, "Telekom to buy Tele.ring for €1.3 billion," August 11, 2005, available at http://www.nytimes.com/2005/08/10/technology/10iht-telering.html.
[64] Hutchison acquired Orange who had acquired ONE (formerly, Connect Austria) in 2007. EU Merger Case No. COMP/M.4809, September 21, 2007, available at http://ec.europa.eu/competition/mergers/cases/decisions/m4809_20070921_20310_en.pdf; E.ON AG. "Financial Statements of E.ON AG for the 2003 Financial Year In Accordance with German GAAP," p. 15; Reuters, "Hutchison wins EU approval for Orange Austria deal," December 12, 2012, available at http://www.reuters.com/article/2012/12/12/us-orangeaustria-hutchison-eu-idUSBRE8BB12220121212.

couple of years of the auction. In the case of Germany, restrictive auction rules in the form of bidding caps contributed to one third of the available 3G spectrum being held off the market for a decade. In the case of the UK, while a set aside initially changed the market structure, the market structure has subsequently returned to the pre-auction configuration.

Looking more broadly at all European countries that auctioned 3G spectrum in the 2000-2001 period and attempted to change market structure through auction (Denmark, Italy, Switzerland and the three discussed above), we see that changes in market structure did not persist in any of the countries; the number of carriers today is unchanged from 2000, except in Austria where there are fewer carriers.[65]

Table 2: 3G Auctions (2000-2001): Subsequent Entry and Exit in European Mobile Markets

Country	Number of Facilities-Based Carriers		Number of Licenses Offered	Number of Entrants via 3G Auction	Number of Exits by		Number of Entries via M&A
	2000	2013			3G Auction Entrants	Incumbents	
Austria	4	3	4-6	2	1	2	2
Denmark	4	4	4	1	0	1	0
Germany	4	4	4-6	2	2	0	1
Italy	4	4	5	2	1	1	0
Switzerland	3	3	4	1	1	0	1
United Kingdom	4	4	5	1	0	1	1

- Exits are defined as horizontal mergers and operation shutdowns (e.g. license revocations and returns) in which the number of carriers in the market is reduced by one.
- See Appendices for additional details and sources.

E. Canadian PCS Auction

In 2001, the Canadian government auctioned 62 regional licenses in the PCS band for a total of 40 MHz.[66] The auction also included an additional 20MHz of spectrum that had been returned to the government as part of a merger settlement with one of the existing carriers, Telus.[67] There were four

[65] In the case of the Netherlands, the auction of 3G spectrum in 2000 did not result in new entry and was marred by allegations of collusion. Klemperer (2002) has characterized regulatory oversight of the Dutch auction as "dysfunctional" and the outcome a "fiasco."
[66] See Industry Canada's summary of the PCS auction at http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/h_sf02076.html.
[67] Industry Canada, "A Brief History of Cellular and PCS Licensing," October 2004, pp. 3-4.

major players in the Canadian wireless market before the 2001 PCS auction: Bell Mobility, Microcell, Rogers, and Telus.[68] The Canadian government did not set aside spectrum for any class of bidders. However, a spectrum cap of 55 MHz limited the ability of certain existing market participants to acquire spectrum in some regions.[69] A 40 MHz spectrum cap was introduced in Canada in 1995 and was imposed on carriers' total holdings of Cellular, PCS and other mobile spectrum. The cap was increased to 55 MHz in 1999 and was in force during the 2001 auction, but was rescinded in August 2004 in order to promote national competition.[70]

Seven qualified bidders participated in the auction, generating a total of $1.48 billion in auction proceeds.[71] The auction ended with five bidders winning 52 licenses. Ten licenses were unsold.[72] Major existing market participants won a majority of the spectrum, which effectively maintained the four-player model in the Canadian wireless market.[73] New entry was limited to regional markets as no new entrant acquired sufficient spectrum to launch national services. In effect, the spectrum cap did not result in the emergence of a new national carrier. Moreover, it restricted the largest carriers from obtaining more PCS spectrum that could be used to improve service in many service areas.

The four-player competition structure maintained over several years, partly because the spectrum holdings were capped at 55 MHz for any single carrier and thus prevented mergers among the four major players. Following the removal of the spectrum cap in August 2004, Rogers acquired Microcell in September 2004.[74] The Canadian market remains comprised of three national carriers, illustrating the extraordinary challenge that regulators face in determining efficient market structure.

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[68] Wall Communications Inc., "A Competitive Assessment of the Canadian Mobile Wireless Industry," November 2001, pp. 58-59. In October 2000, Telus acquired Clearnet Communications Inc. and became Canada's largest wireless company in terms of spectrum position. As a result, Telus's spectrum holdings exceeded the spectrum aggregation limit (55 MHz) in several service areas, and the over-limit portion had to be returned to Industry Canada.

[69] Industry Canada, "Policy and Licensing Procedures for the Auction of Additional PCS Spectrum in the 2 GHz Frequency Range," June 28, 2000, p. ii.

[70] Industry Canada, "Notice No. DGTP-010-04 - Decision to Rescind the Mobile Spectrum Cap Policy," August 27, 2004.

[71] UBS Warburg, "Wireless Spectrum Auction Completed," February 2, 2001, p. 1.

[72] See Industry Canada's summary of the PCS auction at http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/h_sf02076.html.

[73] Goff, R. and A. Mendes, "Canadian Wireless Auctions," Credit Suisse First Boston Corporation, Canada/Telecommunications Services, February 5, 2001, p. 1

[74] Competition Bureau of Canada, "Acquisition of Microcell Telecommunications Inc. by Rogers Wireless Communications Inc.," available at http://www.competitionbureau.gc.ca/eic/site/cb-bc.nsf/eng/00257.html.

F. Canada 2008 AWS Auction

Following the elimination of the spectrum cap, the Canadian wireless market has been comprised of three national mobile wireless network operators: Bell, Telus, and Rogers. In 2007, the three national existing market participants had a total of 94 percent national market share. In addition, there were two regional wireless providers and two MVNOs.[75]

In 2008 the Canadian government auctioned AWS licenses with a band plan similar to the US AWS band plan. The 90 MHz of spectrum was divided into three 20 MHz blocks (2 x 10 MHz paired) and three 10 MHz blocks (2 x 5 MHz). For one of the large blocks and one of the small blocks, licenses were issued for eight provincial service areas. For the remaining blocks, licenses were issued for 59 smaller regional service areas.[76] Unlike the country's 2001 PCS auction, there was no spectrum cap to restrict auction participation.[77] However, the Canadian government set aside 44 percent of the available AWS spectrum (40 MHz out of 90 MHz) for new entrants.[78] The set aside constraint was intended to spur entry on a national scale by excluding the three existing market participant national wireless providers from bidding on the set aside licenses. The set-aside spectrum included the large block (20 MHz) and the small block (10 MHz) of provincial licenses and one of the small blocks (10 MHz) of regional licenses.[79] All of the participants, including existing small regional carriers, were eligible to bid on both the set aside and non-set-aside blocks in any area of the country. This allowed for competition between the three existing market participants for the unrestricted licenses in the auction because only two large blocks (2 x 10 MHz) and one small block (2 x 5 MHz) were unrestricted.[80] The set aside resulted in two new entrants in most markets.[81]

The three existing wireless providers (Rogers, Telus, and Bell) purchased 96 percent of the non-set-aside spectrum (as measured by dollar value of high bids).[82] Set-aside spectrum was sold at a 30 percent discount to unrestricted spectrum, which was considered as effectively subsidizing AWS

[75] Industry Canada, "Policy Framework for the Auction for Spectrum Licenses for Advanced Wireless Services and other Spectrum in the 2 GHz Range," November 2007, p. 2.
[76] Industry Canada (2007), pp. 5-6.
[77] Industry Canada (2007), p. 5.
[78] Dippon, C., "Regulatory Policy Goals and Spectrum Auction Design: Lessons from the Canadian AWS Auction," (2009), NERA Economic Consulting, p. 3.
[79] Industry Canada (2007), pp. 4-6.
[80] Industry Canada (2007), p. 5.
[81] CIBC World Markets, "AWS Auction Finally Ends - $4.25B Is A Big Tally," July 21, 2008, p. 6.
[82] CIBC World Markets, "AWS Auction Finally Ends - $4.25B Is A Big Tally," July 21, 2008, p. 8.

entrants about CAD 600 million.[83] There were new regional entrants. In most markets (except Quebec) there would be two new entrants after the auction.[84]

Moreover, market structure appears effectively unchanged at the present. In March 2012, the three pre-auction existing national operators served 90.6% of subscribers, compared to 94% at the time of the 2008 AWS auction.[85] In addition, of the four largest new entrants (based on total amount of winning bids), two have been acquired by incumbents, one is purportedly for sale, and one has reached a network sharing deal with an incumbent.[86] The four entrants won 92% of set-aside spectrum based on winning bids.[87]

Industry analysts observed that the AWS auction's set-aside rule was an obstacle for the Canadian wireless industry's future development because it discriminated against certain auction participants.[88] Research strongly suggests that discriminatory rules in previous auctions have resulted in the misallocation of resources.[89] In other words, auction results were distorted by participation

[83] Average price for AWS spectrum in Canada ($1.55 per MHz/pop) was three times the average price for AWS spectrum in the U.S. ($0.54 per MHz/pop). CIBC World Markets, "AWS Auction Finally Ends - $4.25B Is A Big Tally," July 21, 2008, p. 1.; CIBC World Markets, "AWS Auction Finally Ends - $4.25B Is A Big Tally," July 21, 2008, p. 4.
[84] CIBC World Markets, "AWS Auction Finally Ends - $4.25B Is A Big Tally," July 21, 2008, p. 5.
[85] TeleGeography GlobalComms Database, Country Profile: Canada, 2012, p. 30; Industry Canada (2007), p. 2.
[86] Quebecor, Globalive, Mobilcity, and Shaw were four largest new entrants in the Canada AWS auction based on total amount of winning bids. In May 2013, TELUS entered into an agreement to acquire Mobilicity for $380 million. Rogers Communications announced on January 14, 2013 that it had signed agreements with Shaw Communications to secure an option to purchase Shaw's AWS spectrum holdings in 2014. Globalive, which operates as Wind Mobile is purportedly in talks to be acquired by Verizon. Rogers and Quebecor reached a network-sharing deal. Dailywireless.org, "Canada's AWS Auction Winds Down," July 8, 2008; Industry Canada, "Auction of Spectrum Licences for Advanced Wireless Services and Other Spectrum in the 2 GHz Range — Licence Winners,"; Mobilcity News Room, DAVE Wireless becomes Mobilcity, February 2, 2010, available at http://mobilicity.ca/newsroom/dave-wireless-becomes-mobilicity/; TELUS Media Release, "TELUS agrees to acquire Mobilicity," May 16, 2013; ROGERS Press Release, "Rogers Communications to Strengthen Core Business through Strategic Transactions with Shaw Communications," January 14, 2013; About Globalive, available at http://globalive.com/about/about-globalive/; CBC News, "Verizon takes aim at telecom Big 3 with possible Wind Mobile bid," June 26, 2013; Reuters, "Rogers, Videotron extend reach with network-sharing deal," May 30, 2013.
[87] Industry Canada (2007), p. 19; Industry Canada, Auction of Spectrum Licences for Advanced Wireless Services and Other Spectrum in the 2 GHz Range — Summary by Licence Block, available at http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf09003.html.
[88] Newcrest, "AWS Spectrum Auction Winners and Losers," Equity Division of TD Securities, July 10, 2008; Waverman, L. and K. Dasgupta, "Time to Set Aside Caps that Don't Fit: The Limits of Spectrum Policy in Canada," *Berkeley Research Group*, February 26, 2011.
[89] See for example, Waverman & Dasgupta (2011), pp. 2, 31; Dippon, C., "Regulatory Policy Goals and Spectrum Auction Design: Lessons from the Canadian AWS Auction," NERA Economic Consulting, July 14, 2009, p. 6.

restrictions, as some winning bidders are left with licenses that they may not have adequate financial resources to exploit and other excluded bidders are left with unmet spectrum needs.

VI. Policy Alternatives to Discriminatory Participation Rules that Promote Competition and New Entry

Acknowledging that restrictive and preferential auction participation rules have been largely unsuccessful in altering market structure does not leave the regulator bereft of tools to promote market entry, competition, and efficient use of spectrum. Distinct from the auction process, the FCC has monitored carriers' spectrum holdings in an effort to deter anti-competitive aggregation of commercial mobile spectrum. In 1994, as the Commission prepared to auction 120 MHz of PCS spectrum, it adopted a cap on spectrum holdings which prohibited a single entity from controlling more than 45 MHz of Cellular, SMR and broadband PCS spectrum (which altogether totaled approximately 190 MHz) in any given cellular market.[90] This cap was later modified and eliminated on January 1, 2003.

In the 2001 Order phasing out the spectrum cap, the FCC explained:

> One basic indicator of meaningful economic competition is that most Americans have a choice of obtaining CMRS from several different providers of service. As of the end of 2000, about 91 percent of US residents lived in a county that was served, at least in part, by three or more different mobile telephony providers, and 75 percent of the US population lived in a county where five or more providers offered service. Furthermore, over 133 million people lived in counties with six or more mobile telephony providers, an increase of 35 percent over the previous year, and 34 million people lived in counties served by seven or more providers, a one-year increase of 170 percent. By contrast, when the spectrum cap was first promulgated in 1994, in all but the few markets where Nextel had then launched service, consumer choice was limited to two cellular providers.[91]

As additional bands of spectrum have been designated as capable of supporting wireless broadband in recent years, the Commission has continued to revise its policies for analyzing spectrum aggregation, including modifications to its spectrum screen.[92] In fact, in a proceeding separate from the incentive auction proceeding, the Commission is considering modifying its rules regarding spectrum

[90] 9th Competition Report, ¶ 87-89; FCC, "In the Matter of Policies Regarding Mobile Spectrum Holdings: Notice of Proposed Rule Making," WT Docket No. 12-269, September 28, 2012, ¶ 7.
[91] FCC, "In the Matter of 2000 Biennial Regulatory Review Spectrum Aggregation Limits For Commercial Mobile Radio Services," FCC 01-328, December 18, 2001, ¶ 31.
[92] FCC, "In the Matter of Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993 Annual Report and Analysis of Competitive Market Conditions With Respect to Mobile Wireless, Including Commercial Mobile Services: Fourteenth Report," FCC 10-81, May 20, 2010, ¶263.

aggregation limits.[93] Additionally, the Commission may monitor spectrum licensees' practices in the context of competition policy. For example, the FCC recently issued a Notice of Inquiry regarding allegations of spectrum-related anti-competitive behavior in the Fixed Satellite Services industry.[94]

There is broad consensus that the most important action regulators can take to foster competitive wireless markets is to increase the supply of the critical spectrum input.[95] For example, regulators may adopt policies that are intended to encourage entry by considering and granting, in a timely fashion, requests to repurpose spectrum from other services, including spectrum used by the government, to terrestrial mobile broadband. Regulators also can encourage entry through secondary market transactions by adopting predictable and principled review of transactions and eliminating disincentives to invest in the sector. Indeed, the US secondary market is quite robust; following the PCS auctions in the mid-1990s all major entry in the US wireless market has been through spectrum re-purposing or M&A.[96] One current example of entry through repurposing is DISH, which holds 40 MHz of spectrum that the FCC recently repurposed from Mobile Satellite Services to terrestrial mobile

[93] FCC, "In the Matter of Policies Regarding Mobile Spectrum Holdings: Notice of Proposed Rule Making," WT Docket No. 12-269, September 28, 2012. Although the spectrum holdings proceeding is procedurally separate from the incentive auction proceeding, it could affect who is able to participate in the incentive auction, and the extent to which they can participate, depending on the timing of the proceedings and the rules developed in the spectrum holdings proceeding.

[94] FCC, "In the Matter of Issues Related to Allegations of Warehousing and Vertical Foreclosure in the Satellite Space Segment," IB Docket No. 13-147, June 7, 2013, pp. 1, 2.

[95] See e.g., Cramton, et. al. (2011); Hazlett & Munoz (2009).

[96] In July 2000, Deutsche Telekom announced that its subsidiary T-Mobile would enter the US wireless market through the acquisition of VoiceStream Wireless and Powertel for a total of approximately $50 billion. At the time of the acquisition, VoiceStream and Powertel had approximately 2.3 million and 700,000 subscribers, respectively. In July 2013, Softbank, a Japanese telecommunications and Internet company, completed its acquisition of Sprint for approximately $21.6 billion, including a $5 billion capital infusion. The FCC approved rules allowing DISH to use 40 MHz of spectrum, which had previously been allocated to satellite services, for a ground-based cellular network in December 2012. The trade press has reported that DISH may be seeking to partner with an existing wireless network operator. DISH is also pursuing additional spectrum, including the licenses held by Lightsquared, which is currently in bankruptcy. The New York Times, "Deutsche Telekom to Pay $50 Billion for U.S. Company," July 24, 2000; CNN Money, "Telekom bids for Powertel," August 28, 2000; Sprint Press Release, "Sprint and SoftBank Announce Completion of Merger," July 10, 2013; The Wall Street Journal, "FCC Approves DISH for Cellular Play," December 11, 2012; FierceWireless, "DISH drops pursuit of Clearwire," June 26, 2013, available at http://www.fiercewireless.com/story/dish-drops-pursuit-clearwire/2013-06-26; telecompaper, "Dish raises LightSquared bid to USD 2.2 bln," July 25, 2013, available at http://www.telecompaper.com/news/dish-raises-lightsquared-bid-to-usd-22-bln--957201; FierceWireless, "Dish must build 40% of its wireless network in 4 years, FCC says," December 18, 2012, available at http://www.fiercewireless.com/story/dish-must-build-40-its-wireless-network-4-years-fcc-says/2012-12-18.

broadband.[97] It is therefore not surprising that reallocating or repurposing spectrum, merger review policy, and antitrust enforcement have emerged as the most important and effective policy tools for preserving competition.

Entry through secondary market transactions also can have a positive effect on competition and market structure, to the extent that the acquiring firm intends to invest in the market and improve the financial and operating performance of an existing service provider.[98] Building on the infrastructure, operational experience, and brand recognition of an existing carrier by adding significant external financial resources of a new partner arguably offers an opportunity to alter the market's competitive structure. For example, Softbank is expected to invest billions of dollars in the U.S. mobile broadband sector following its acquisition of Sprint.[99]

VII. Conclusion

Congress authorized the FCC in 1993 to assign spectrum licenses using competitive bidding mechanisms to "promote… [the] efficient and intensive use of the electromagnetic spectrum."[100] Our review of the experience in both the U.S. and abroad shows that restrictive and preferential participation rules disrupt the auction process, jeopardizing the benefits of releasing additional spectrum into the market. Restrictions also have reduced auction revenues, resulted in large amounts of fallow spectrum, and delayed or reduced a range of consumer benefits. Furthermore, these rules have proven ineffective – and counter-productive – as means to stimulate sustainable entry and/or alter the market structure in a way that enhances competition.

Indeed, looking to auctions – and auction structure and rules – as a primary tool for regulators to impact retail competition or market structure produces unintended consequences that undermine the mobile markets and ultimately harm consumers. For example:

[97] FCC, "In the Matter of Service Rules for Advanced Wireless Services in the 2000-2020 MHz and 2180-2200 MHz Bands," FCC 12-151, December 17, 2012, pp. 2, 9, 10; FierceWireless, "Dish must build 40% of its wireless network in 4 years, FCC says," December 18, 2012, available at http://www.fiercewireless.com/story/dish-must-build-40-its-wireless-network-4-years-fcc-says/2012-12-18.

[98] As noted earlier, MVNOs provide competition as well, though not based on their own ownership of facilities.

[99] Sprint Press Release, "Sprint and SoftBank Announce Completion of Merger," July 10, 2013; Infoworld "FCC approves Softbank's $21.6B acquisition of Sprint," July 8, 2013, available at http://www.infoworld.com/d/the-industry-standard/fcc-approves-softbanks-216b-acquisition-of-sprint-222161.

[100] 47U.S.C. § 3099(j)(3)(D). H.R. 2264 "Omnibus Budget Reconciliation Act of 1993."

- Because of restrictive and preferential participation rules in place for the 1994 U.S. PCS spectrum auctions, there was a loss in consumer welfare of as much as $70 billion. Financing difficulties for new entrants buying set-aside licenses idled a substantial amount of spectrum for many years.
- Following the PCS auctions in the mid-1990s, all major entry in the US wireless market has been through spectrum re-purposing or M&A (e.g., T-Mobile, Softbank, DISH). As the size of the market has grown, the incremental spectrum introduced through auctions has become smaller relative to the amount already in the market, reducing the impact of spectrum auctions on market structure.
- In Canada and several European countries, restrictive and preferential policies intended to encourage market entry distorted the auction process and were unsuccessful. Although the initial result was a change in market structure, market forces resulted in a return to pre-auction market structure with the same number of, or fewer, national competitors before and after.
- In the case of German 3G auctions, policies intended to encourage market entry were unsuccessful and resulted in a 10-year delay in the assignment of one-third of the 3G spectrum, delaying its development and the benefits consumers would have otherwise enjoyed.

The ineffectiveness of discriminatory participation rules in affecting market structure both in the U.S. and abroad, and the harm that discriminatory participation rules have ultimately imposed on consumers, through delayed deployment of new spectrum, demonstrate that such auction rules are neither a useful nor desirable policy tool for the FCC to seek to shape or structure the marketplace. The record shows that alternative assignment policies, such as spectrum repurposing, and market-based activities, such as secondary market transactions, are more likely to expand competition, enhance consumer choice, and encourage innovation and investment.

VIII. Appendices

Appendix A: US Wireless Industry Development

U.S. Wireless Industry Development (1993 vs. 2012)

Year	1993	2012
Wireless Subscriber Connections (millions)	16.0	326.4
Wireless Penetration of Population (%)	6.2	101.0
Wireless-Only Households (%)	n/a	35.8
Total 12-Month Wireless Revenue ($ billions)	10.9	185.0
Cumulative Capital Investment ($ billions)	14.0	365.4
Cell Sites (thousands)	12.8	301.8
Population Coverage (millions)	75.9 [A]	322.8 [B]
% Population Coverage (%)	29.4 [C]	99.9 [D]
% Population Served by 3 or More Providers (%)	0.0 [E]	97.2 [D]
% Population Served by 5 or More Providers (%)	0.0 [E]	80.4 [D]

Notes:

[A] Population coverage of 1993 is assumed to be equal to the population coverage of McCaw, the nation's largest provider of cellular services in 1993.

[B] The estimate of the U.S. population in 2012 equals 323.2 million, calculated as the wireless subscriber connections (326.5 million) divided by the wireless penetration of population (101.0%). The population coverage is the product of U.S. population and the percentage of population coverage (99.9%) for 2012.

[C] The estimate of the U.S. population in 1993 equals 258.2 million, calculated as the wireless subscriber connections (16.0 million) divided by the wireless penetration of population (6.2%). The percentage population coverage of 1993 is calculated as the population coverage (75.9 million) divided by the estimate of the U.S. population in 1993.

[D] FCC estimates based on Mosaik Solutions (formerly American Roamer) database as of the third quarter of 2012.

[E] Majority of the cellular service areas had duopoly competition structure starting 1991 and through 1994 because there were only two licenses per area issued by FCC.

Sources:

[1] CTIA's Semi-Annual Wireless Industry Survey, 2012 second issue.

[2] CTIA, Wireless Quick Facts, http://www.ctia.org/advocacy/research/index.cfm/aid/10323.

[3] FCC, Memorandum Opinion and Order, Docket No. 64-238, File No. ENF-93-44, September 19, 1994, pp. 5840-5841.

[4] FCC, Annual Commercial Mobile Radio Services (CMRS) Competition Report, First Report, 1995, p. 2; Third Report, 1998, Figure 3; Sixteenth Report, 2013, pp. 6, 48.

Appendix B: European Mobile Market Evolution

3G Auctions (2000-2001): Subsequent Entry and Exit in European Mobile Markets

Country [A]	Number of Facilities-Based Carriers		Number of Licenses Offered [B]	Number of Entrants via 3G Auction	Number of Exits by [C]		Number of Entry via M&A
	2000	2013			3G Auction Entrants	Incumbents	
	[1] [2]	[3] [4]	[1] [2]	[1] [2]	[5]	[5]	[5]
Austria	4	3	4-6	2	1	2	2
Denmark	4	4	4	1	0	1	0
Germany	4	4	4-6	2	2	0	1
Italy	4	4	5	2	1	1	0
Switzerland	3	3	4	1	1	0	1
United Kingdom	4	4	5	1	0	1	1

Notes:

[A] Listed above are European countries that held 3G spectrum auctions during 2000-2001. Countries are listed only if there was new entry through the 3G spectrum auction.

[B] Austria and Germany auctioned 12 blocks of spectrum from which bidders could bid for either two or three blocks, and effectively offered four or six licenses in the auctions.

[C] Exits are defined as horizontal mergers and operation shutdowns (e.g. license revocations and returns) in which the number of carriers in the market is reduced by one.

Sources:

[1] European Commission, "Comparative Assessment of the Licensing Regimes for 3G Mobile Communications in the European Union and their Impact on the Mobile Communications Sector," June 25, 2002, Exhibit 9 and Exhibit 12.

[2] Gruber, Harald, "The Economics of Mobile Telecommunications," Cambridge University Press, 2005, p. 257.

[3] Credit Suisse Telecommunication Services, "European Telecoms Factsheet," December 12, 2012.

[4] Reuters, “Hutchison wins EU approval for Orange Austria deal,” December 12, 2012, Available at http://www.reuters.com/article/2012/12/12/us-orangeaustria-hutchison-eu-idUSBRE8BB12220121212.

[5] See Appendices for additional details and sources.

B1. Austria

4 MNOs in 2000: Mobilcom (A1), Max.mobil (rebranded as T-Mobile[1]), Connect Austria (One), Tele.ring (Vodafone) [2]		
Time	**Market Activity**	**Description**
Nov 2000	3G Auction	Two Entrants: Hutchison 3, 3G Mobile [3]
May 2001	M&A Entry	Western Wireless International (WWI) acquired Tele.ring [4]
Dec 2003	Entrant Exit (Consolidation)	3G Mobile was acquired by Mobilcom [5] Some of 3G Mobile's frequency was later sold to T-Mobile[6]
Aug 2005	Incumbent Exit (Consolidation)	Tele.ring (WWI) was acquired by T-Mobile[7]
Aug 2007	M&A Entry	Orange acquired Connect Austria (One)[8]
Sep 2010	4G Auction (2.6 GHz)	All licenses won by incumbents[9]
Dec 2012	Incumbent Exit (Consolidation)	Orange (One) was acquired by Hutchison 3[10]
3 MNOs in 2013: Mobilcom (A1), T-Mobile, Hutchison 3 [11]		

B2. Denmark

4 MNOs in 2000: TDC, Sonofon/Telenor, TeliaSonera, Orange[12]		
Time	**Market Activity**	**Description**
Sep 2000	3G Auction	One Entrant: Hutchison 3 (Hi3G)[13]
Jul 2004	Incumbent Exit (Consolidation)	Orange was acquired by TeliaSonera[14]
May 2010	4G Auction (2.6 GHz)	All licenses won by incumbents[15]
Jun 2012	4G Auction (800 MHz)	All licenses won by incumbents[16]
4 MNOs in 2013: TDC, Telenor, TeliaSonera, Hutchison 3[17]		

B3. Germany

4 MNOs in 2000: T-Mobile, Mannesmann-Vodafone, E-Plus, Viag Interkom (rebranded as O2[18]) [19]		
Time	**Market Activity**	**Description**
Jul 2000	3G Auction	Two Entrants: Quam (Group 3G), Mobilcom [20]
Nov 2002	Entrant Exit	Quam's licenses revoked[21]
Dec 2003	Entrant Exit	Mobilcom's licenses revoked[22]
Oct 2005	M&A Entry	Telefonica acquired O2[23]
May 2010	4G Auction (800 MHz, 2.6 GHz)	All licenses won by incumbents[24]
4 MNOs in 2013: T-Mobile, Vodafone, E-Plus, Telefonica (O2) [25]		

B4. Italy

4 MNOs in 2000: TIM (Telecom Italia Mobile), Omnitel (Vodafone), Wind, Blu (BT) [26]		
Time	**Market Activity**	**Description**
Oct 2000	3G Auction	Two Entrants: Ipse, Hutchison 3 (H3G) [27]
Aug 2002	Incumbent Exit	Blu went out of business[28]
Jan 2006	Entrant Exit	Ipse had the UMTS license revoked and shut down services[29]
Sep 2011	4G Auction (800 MHz)	All licenses won by incumbents[30]
4 MNOs in 2013: TIM, Vodafone, Wind, Hutchison 3 [31]		

B5. Switzerland

3 MNOs in 2000: Swisscom, Orange, dSpeed (diAX/Sunrise-TeleDenmark)[32]		
Time	**Market Activity**	**Description**
Nov 2000	3G Auction	One Entrant: 3G Mobile AG (aka Team 3G, owned by Telefonica)[33]
Apr 2006	Entrant Exit	3G Mobile AG went out of business[34]
Sep 2010	M&A Entry	diAX/Sunrise was acquired by CVC Capital Partners[35]
Feb 2012	4G Auction (800 MHz)	All licenses were won by incumbents[36]
3 MNOs in 2013: Swisscom, Orange, Sunrise[37]		

B6. United Kingdom

4 MNOs in 2000: Vodafone, BT Cellnet (O2[38]), Orange, One2One (rebranded as T-Mobile[39])[40]		
Time	**Market Activity**	**Description**
Mar 2000	3G Auction	One Entrant: Hutchison 3 (TIW)[41]
Oct 2005	M&A Entry	Telefonica acquired O2[42]
May 2010	Incumbent Exit / Consolidation	Orange merged with T-Mobile, creating Everything Everywhere[43]
Feb 2013	4G Auction (800 MHz, 2.6 GHz)	All licenses won by all four incumbents and one new entrant (Niche Spectrum Ventures, subsidiary of BT)[44]
4 MNOs in 2013: Vodafone, O2 (Telefonica), EE (Everything Everywhere), Hutchison 3[45]		

Appendix B Notes and Sources:

[1] Max.mobil became wholly owned by Deutschen Telekom starting April 2000, and was operated under the holding company T-Mobile International AG. (Source: 2000 Deutschen Telekom Form 20-F as filed with the Securities and Exchange Commission on May 4, 2001); Max.mobil was rebranded as T-Mobile during 2002. (Source: Telecompaper, "T-Mobile takes first step in global rebranding," February 4, 2002, available at http://www.telecompaper.com/news/tmobile-takes-first-step-in-global-rebranding--296355)
[2] Gruber (2005), p. 257.
[3] Gruber (2005), p. 257.
[4] Vodafone Group Plc, "Annual Report & Accounts and Form 20-F For the year ended 31 March 2002," 2002, p. 9, available at http://www.vodafone.com/content/dam/vodafone/investors/annual_reports/annual_report_accounts_2002.pdf.
[5] Telefonica Press Release, "Telefónica Móviles and mobilkom austria reach agreement on the sale of 3G Mobile," December 23, 2003, available at http://www.telefonica.com/en/shareholders_investors/pdf/hr231203.pdf.
[6] Telegeography, "T-Mobile buys extra 3G bandwidth," April 5, 2004, available at http://www.telegeography.com/products/commsupdate/articles/2004/04/05/t-mobile-buys-extra-3g-bandwidth/
[7] New York Times, "Telekom to buy Tele.ring for €1.3 billion," August 10, 2005, available at http://www.nytimes.com/2005/08/10/technology/10iht-telering.html
[8] EU Merger Case No. COMP/M.4809, September 21, 2007, available at http://ec.europa.eu/competition/mergers/cases/decisions/m4809_20070921_20310_en.pdf
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[11] Credit Suisse, "European Telecoms Factsheet," December 12, 2012; Reuters, "Hutchison wins EU approval for Orange Austria deal," December 12, 2012, available at http://www.reuters.com/article/2012/12/12/us-orangeaustria-hutchison-eu-idUSBRE8BB12220121212.
[12] Gruber (2005), p. 258.
[13] Gruber (2005), p. 258.
[14] Mobile Tech News, "TeliaSonera acquires Orange Denmark," October 11, 2004, available at http://www.mobiletechnews.com/info/2004/10/11/103654.html
[15] Aetha, "Spectrum value of 800MHz, 1800MHz and 2.6GHz," July 2012, pp. 38-39, available at http://stakeholders.ofcom.org.uk/binaries/consultations/award-800mhz/statement/spectrum-value.pdf
[16] Aetha, "Spectrum value of 800MHz, 1800MHz and 2.6GHz," July 2012, pp. 23-24, available at http://stakeholders.ofcom.org.uk/binaries/consultations/award-800mhz/statement/spectrum-value.pdf
[17] Credit Suisse, "European Telecoms Factsheet," December 12, 2012.
[18] Viag Interkom was launched in 1995 as a joint venture company between BT and German group Viag (Source: BT Archives 1995, available at http://www.btplc.com/Thegroup/BTsHistory/1984onwards/1995.htm). Viag Interkom was wholly owned by BT since February 2001 (Source: BT Archives 2001, available at http://www.btplc.com/Thegroup/BTsHistory/1984onwards/2001.htm). In November 2001, MmO2 (formerly BT Wireless) demerged from BT to become an independent wholly owned company (Source: About Telefonica Europe, Milestones, available at http://www.telefonica.com/en/europe/html/about_telefonica_europe/key_milestones.shtml). MmO2 was rebranded as O2 in 2002 (Source: Utility Week, "MMO2.MMO2 completed its restructuring in August," October 18, 2002).
[19] Gruber (2005), p. 253.
[20] Gruber (2005), p. 253.
[21] Light Reading Mobile, "German 3G Player Folds," July 24, 2002, available at http://www.lightreading.com/german-3g-player-folds/240040189.

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[23] 3G News, "Telefónica Acquires UK Mobile Operator O2," October 31, 2005, available at http://www.3g.co.uk/PR/Nov2005/2135.htm
[24] Aetha, "Spectrum value of 800MHz, 1800MHz and 2.6GHz," July 2012, pp. 16-17, 35, available at http://stakeholders.ofcom.org.uk/binaries/consultations/award-800mhz/statement/spectrum-value.pdf
[25] Credit Suisse, "European Telecoms Factsheet," December 12, 2012.
[26] Gruber (2005), p. 255.
[27] Gruber (2005), p. 255.
[28] Blu went out of business, and its shares were broken up and acquired by the other existing carriers (TIM, Omnitel, Wind, and H3G). BBC News, "Italian mobile operator carved up," August 7, 2002, available at http://news.bbc.co.uk/2/hi/business/2178161.stm
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[30] Aetha, "Spectrum value of 800MHz, 1800MHz and 2.6GHz," July 2012, pp. 18, available at http://stakeholders.ofcom.org.uk/binaries/consultations/award-800mhz/statement/spectrum-value.pdf
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[33] Gruber (2005), p. 257; Telefonica Form 20-F, 2001, p. 44.
[34] Federal Communications Commission ComCom, "ComCom revokes Telefonica's UMTS licence," April 13, 2006, available at http://www.bakom.admin.ch/dokumentation/medieninformationen/00471/index.html?lang=en&msg-id=4711
[35] CVC Group Press Release, "CVC Capital Partners and TDC Sign Agreement on Sunrise," September 17, 2010, available at http://www.cvc.com/media-centre.htmx?mediaitem=1071010110101&tabyear=2010
[36] Aetha, "Spectrum value of 800MHz, 1800MHz and 2.6GHz," July 2012, p. 22-23, available at http://stakeholders.ofcom.org.uk/binaries/consultations/award-800mhz/statement/spectrum-value.pdf
[37] Credit Suisse, "European Telecoms Factsheet," December 12, 2012.
[38] In November 2001, MmO2 (formerly BT Wireless) demerged from BT to become an independent wholly owned company (Source: About Telefonica Europe, Milestones, available at http://www.telefonica.com/en/europe/html/about_telefonica_europe/key_milestones.shtml). MmO2 was rebranded as O2 in 2002 (Source: Utility Week, "MMO2.MMO2 completed its restructuring in August," October 18, 2002).
[39] One2One was wholly owned by Deutschen Telekom, and was operated under the holding company T-Mobile International AG. (Source: 2000 Deutschen Telekom Form 20-F as filed with the Securities and Exchange Commission on May 4, 2001); One2One was rebranded as T-Mobile during 2002. (Source: Telecompaper, "T-Mobile takes first step in global rebranding," February 4, 2002, available at http://www.telecompaper.com/news/tmobile-takes-first-step-in-global-rebranding--296355)
[40] Gruber (2005), p. 245.
[41] Gruber (2005), p. 247; Hutchison Whampoa Limited Press Release, "TIW wins UMTS licence in the United Kingdom, TIW and Hutchison Whampoa announce cooperation on UK UMTS," April 27, 2000.
[42] 3G News, "Telefónica Acquires UK Mobile Operator O2," October 31, 2005, available at http://www.3g.co.uk/PR/Nov2005/2135.htm
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http://media.ofcom.org.uk/2013/02/20/ofcom-announces-winners-of-the-4g-mobile-auction/; Reuters, RPT-UPDATE 2-UK gets less-than-expected 2.3 bln stg from airwaves sale, 20 February 2013, available at http://uk.reuters.com/article/2013/02/20/ofcom-4g-idUKL6N0BK1C920130220.

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