

Private Sector Investment and Employment Impacts of Reassigning Spectrum to Mobile Broadband in the United States

Authors:

David W. Sosa, Ph.D.
415-263-2217 | dsosa@analysisgroup.com

Marc Van Audenrode, Ph.D.
514-394-4477 | mvanaudenrode@analysisgroup.com

August 2011

Sosa is a vice president and Van Audenrode is a managing principal at Analysis Group, Inc. Financial support for this research was provided by Mobile Future. Responsibility for any errors or omissions rests with the authors.

EXECUTIVE SUMMARY

Mobile broadband is critical to the U.S. communications infrastructure and our future economy. Private sector investment, with substantial job creation benefits, can be facilitated by the reassignment of spectrum to mobile broadband. Building on previous studies, we estimate that the reassignment of 300 MHz of spectrum to mobile broadband within five years will spur \$75 billion in new capital spending, creating more than 300,000 jobs and \$230 billion in additional Gross Domestic Product (GDP). The release of an additional 200 MHz of new spectrum after five years will create an additional 200,000 jobs and increase GDP by an additional \$155 billion. These estimates represent the tip of the iceberg in terms of economic benefits. Reassigning additional spectrum to mobile broadband also would generate substantial spillover effects as companies such as Apple, Google and Qualcomm, small application developers and other innovative start-up companies rush to create new mobile broadband products and services. Given published estimates of the spillover effects from communications and broadband investment, it seems likely that the spillover effects from the reassignment of spectrum to mobile broadband will exceed, by a considerable margin, the multiplier effects that we present here. A delay in the reassignment of spectrum will necessarily delay the consequent job and economic output benefits that we identify.

1. INTRODUCTION

Background

Mobile broadband is emerging as a critical feature of the U.S. communications infrastructure and essential to the future of our economy. Capital spending by companies in the wireless sector has been substantial over the past decade and has laid a solid foundation of modern connected infrastructure that has contributed significantly to economic growth and job creation throughout the United States. Between 2002 and 2010, capital spending in the wireless industry exceeded \$185 billion,¹ creating, on average, approximately 420,000 jobs throughout the economy.² In the current stagnant economic environment, policymakers should be concerned with facilitating private sector investment, which will generate market-based growth and job creation. Stimulating investment in mobile broadband infrastructure will create jobs, spur consumer demand and facilitate the innovation of new goods and services.

Wireless spectrum is an essential input to mobile broadband services and there is widespread agreement that spectrum constraints are challenging for the industry. For example, U.S. networks are currently operating at 80 percent of capacity, well above the aggregate utilization rate of 65 percent for all countries worldwide.³ Acknowledging that mobile broadband is “a key platform for innovation in the United States over the next decade,”⁴ the Federal Communications Commission (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.”⁵ As a remedy for this problem, the FCC has proposed to make 500 MHz available for mobile broadband use over the next ten years, including 300 MHz in the next five years. Experts have estimated that between two and four times this amount will be needed by 2020 to continue supporting consumer demands.⁶ In helping to reallocate spectrum to meet evolving consumer demand, policymakers have a unique opportunity to facilitate private sector investment in critical wireless infrastructure that will create jobs, spur demand and encourage innovation.

Building on past studies of the economic impact of investment in communications infrastructure, updated with current data, we estimate the likely macroeconomic effect of investment by the wireless industry to build out the spectrum release proposed by the FCC.⁷ We find that the build out of 300 MHz of new

¹ Robert F. Roche and Liz Dale, “Wireless Investment and Build-Out Report,” CTIA Public Affairs (May 2011), Table 7.

² Job creation estimate based on CTIA investment figures and BEA 2010 employment multiplier described below.

³ Credit Suisse, “Global Telecom Equipment: Global Wireless Capex Survey,” (July 2011).

⁴ National Broadband Plan, Federal Communications Commission, Chapter 5, p. 75.

⁵ *Ibid.*, p. 77.

⁶ “The ITU released an analysis in 2006 predicting that the total amount of spectrum needed to support mobile broadband in developed countries like the U.S. would be 1,300 megahertz by 2015 and up to 1,720 megahertz by 2020.” National Broadband Plan, Federal Communications Commission, Chapter 5, p. 84.

⁷ See, e.g.: Thomas W. Hazlett, Coleman Bazelon, John Rutledge and Deborah Allen Hewitt, “Sending the Right Signals: Promoting Competition through Telecommunications Reform” U.S. Chamber of Commerce (September 2004); Crandall, Robert, William Lehr and Robert Litan, “The Effects of Broadband Deployment on Output and Employment: A Cross-sectional Analysis of U.S. Data,” *Issues in Economic Policy* (2007); Jeffrey A. Eisenach, Hal J. Singer and Jeffrey D. West, “Economic Effects of Tax Incentives for Broadband Infrastructure Deployment,” Fiber-to-the-Home Council (2009); Charles Davidson and Bret Swanson, “Net Neutrality, Investment & Jobs: Assessing the Potential Impacts of the FCC’s Proposed Net Neutrality Rules on the Broadband Ecosystem,” Advanced Communications Law & Policy Institute at New York Law School (June 2010); T. Randolph Beard, George S. Ford, and Hyeonwoo Kim, “Jobs, Jobs, Jobs: Communications Policy and Employment

spectrum made available for commercial mobile broadband uses will create more than 300,000 new jobs and an additional \$230 billion in GDP over five years, accounting for direct, indirect and induced effects. In addition, we estimate that the long-run impact of ongoing maintenance and upgrade capital spending associated with the newly deployed spectrum will be almost 340,000 new jobs and a \$50 billion annual increase in GDP. The follow-on release of an additional 200 MHz of new spectrum within 10 years will create more than 200,000 new jobs and increase GDP by an additional \$154 billion.

These estimates are likely just the tip of the iceberg in terms of long-term economic benefits of reassigning spectrum to mobile broadband. The FCC has identified mobile broadband as a “transformative” technology that is likely to yield more economic benefits, in terms of new and innovative products and services, than internet computing or mobile voice communications. The additional spectrum will foster innovation, not only by wireless carriers, but also by companies such as Apple, Intel, Google, Qualcomm, and countless small mobile application developers and start-up companies. The additional spectrum also will facilitate increased broadband penetration. One recent study estimated that each one percent increase in broadband penetration creates approximately 300,000 jobs.⁸

Our study demonstrates the substantial benefits to the U.S. economy – in terms of job creation, GDP gains and opportunities for innovation – from spectrum reassignment. Any delay in the reassignment of spectrum to mobile broadband would necessarily delay the realization of these benefits because there would be less private sector investment, fewer new jobs created and lower overall economic output.

Methodology

We estimate the likely impacts on total employment and on GDP of incremental investment by the wireless industry to build out the FCC’s proposal to make 300 MHz of additional spectrum available to commercial providers of mobile broadband within five years. We also consider the impact of an additional 200 MHz in 10 years, as proposed by the FCC. Based on our estimates of capital spending that is likely to result from the availability of additional spectrum and using data from the U.S. Bureau of Economic Analysis (BEA), we estimate the associated increase in employment and GDP from three economic effects:

- **Direct Effects:** Direct effects include the impacts on employment and output as a result of the initial investments made by companies acquiring direct access (via winning auction bids) to the newly available spectrum.
- **Indirect Effects:** Indirect effects include the employment and output impacts on other firms, such as vendors, from purchases made by the companies who are making investments as a result of their acquisition of newly available spectrum.

Effects in the Information Sector,” Phoenix Center Policy Bulletin No. 25, Phoenix Center for Advanced Legal and Economic Public Policy Studies (October 2010); Crandall, Robert W. and Hal J. Singer, “The Economic Impact of Broadband Investment,” Broadband for America (February 2010).

⁸ Crandall, Lehr and Litan (2007).

- **Induced Effects:** Induced economic impacts are generated by expenditures made by employees of the firms that benefit from the direct and indirect effects. Because consumer spending accounts for approximately 70 percent of GDP, it is important to include an estimate of the induced impact to evaluate overall economic impact.

2. PRIVATE SECTOR CAPITAL SPENDING STIMULATED BY SPECTRUM REASSIGNMENT

Beginning in 1994, the FCC auctioned PCS licenses for 120 MHz of spectrum for mobile telephony. Hazlett et. al. (2004) estimate that in the five years from 1994 to 1998 the wireless industry invested \$33.8 billion to build out PCS networks.⁹

To project the effects of making an additional 300 MHz of bandwidth available to service providers today, we assume an increase in capital spending (in 2010 dollars) proportional to the investment that occurred following PCS licensing, adjusting for the current proposal to issue licenses for 300 MHz relative to the 120 MHz of spectrum allocated to PCS. Our estimates of additional investment that will result from build-out and deployment of newly available spectrum are derived from incremental capital investment data as reported by the wireless industry and exclude the cost of acquiring spectrum via auction.¹⁰ These estimates of capital spending increase over time, consistent with the observed ramp-up in capital spending during the build out of the PCS spectrum. As reported in Table 1, we estimate that an additional \$75.3 billion of capital spending over a five-year period will be required to build out mobile broadband networks using 300 MHz of reassigned spectrum.¹¹

⁹ Hazlett et. al. (2004), p. 103.

¹⁰ Roche and Dale (2011), pp. 21 and 38, Tables 6 and 7.

¹¹ Because not all 120 MHz of PCS spectrum was deployed during the period 1994-1998, our estimate of build out costs likely is conservative. It also reflects a reasonable balance between deployment of reallocated spectrum by incumbent carriers and by greenfield developers, who likely will experience higher capital spending than PCS carriers because of more stringent environmental review processes and greater siting challenges currently than at the time of the PCS build out.

Table 1: 5-Year Impact of Spectrum Reassignment on Capital Spending (\$ millions)

A. Prior to PCS Auctions		1991	1992	1993	Average	Notes/Sources	
[1]	1991-1993 Capital Spending	\$2,389	\$2,590	\$2,694	\$2,558	CTIA's Wireless Industry Investment and Build-Out Report (May 2011), p. 21, Table 6.	
[2]	PPI Deflator (to 2010 Dollars)	0.948	0.933	0.921		PPI for Broadcast and Wireless Communications Equipment industry from Bureau of Labor Statistics (http://www.bls.gov/ppi/#data). 2010 PPI divided by PPI for 1991-1993.	
[3]	1991-1993 Capital Spending in 2010 Dollars (as Adjusted by PPI Deflator)	\$2,265	\$2,417	\$2,482	\$2,388	= [1] x [2].	
B. Capital Spending, 1994-1998		1994	1995	1996	1997	1998	
[4]	1994-1998 Capital Spending	\$4,982	\$5,141	\$8,493	\$13,484	\$14,484	CTIA's Wireless Industry Investment and Build-Out Report (May 2011), p. 21, Table 6.
[5]	PPI Deflator (to 2010 Dollars)	0.912	0.916	0.910	0.897	0.899	PPI for Broadcast and Wireless Communications Equipment industry from Bureau of Labor Statistics (http://www.bls.gov/ppi/#data). 2010 PPI divided by PPI for 1994-1998.
[6]	1994-1998 Capital Spending in 2010 Dollars (as Adjusted by PPI Deflator)	\$4,546	\$4,709	\$7,727	\$12,094	\$13,015	= [4] x [5].
C. Additional Capital Spending, 1994-1998 (in 2010 Dollars)							
[7]	1991-1993 PPI Adjusted Average (prior to PCS auctions)	\$2,388	\$2,388	\$2,388	\$2,388	\$2,388	From [3].
[8]	PCS Capital Spending in 2010 Dollars (120 MHz)	\$2,158	\$2,321	\$5,339	\$9,706	\$10,627	= [6] - [7]. Hazlett et al. (2004) estimate capital costs for buildout of 120 MHz of PCS spectrum over 5 years.
[9]	Build out Capital Spending per 100 MHz (2010 dollars)	\$1,798	\$1,934	\$4,449	\$8,088	\$8,856	= [8] x 100/120.
D. Capital Spending, Years 1 - 5 (300 MHz)		Year 1	Year 2	Year 3	Year 4	Year 5	
[10]	Build out Capital Spending for 300 MHz	\$5,395	\$5,803	\$13,348	\$24,264	\$26,568	= [9] x 3

3. THE IMPACT OF ADDITIONAL CAPITAL SPENDING

In the current stagnant economic environment, the U.S. economy has unused resources, including capital that is available for investment but has not been deployed, and unemployed workers. We know from fundamental economic theory that increasing purchases in one sector will cause an economic “ripple effect.” In this case, increased capital spending by mobile broadband service providers will cause increases in spending by direct suppliers to the industry and by suppliers’ suppliers. Moreover, newly created jobs and additional economic output generate more consumer spending, and this new spending creates yet more jobs and economic output. This is the multiplier effect described in macroeconomics textbooks. As we explain below, U.S. Bureau of Economic Analysis (BEA) multipliers, for example, suggest that each additional \$1 of telecom capital spending leads to \$3.08 in extra output, while every \$1 million rise in telecom capital spending leads to more than 20 new jobs.

Based on the FCC’s proposal and historic data, we estimate incremental investment by the wireless sector and the associated impact throughout the U.S. economy in terms of increased employment and GDP of building out and integrating the reassigned spectrum. As described above, additional spillover effects from the increased availability of spectrum are likely to be very large. Below, we describe in more detail

our estimates of additional capital investment to quantify economic impacts on employment and GDP using multipliers from the BEA, Regional Economic Input-Output Modeling System (RIMS II).

The government measures these multipliers for each sector, so that we can calculate the effect of each dollar of capital spending on the rest of the economy.

Employment

We can expect job creation as a consequence of new capital investment in the deployment of mobile broadband. Several authors have examined the expected impact of investment in wireless and mobile broadband using BEA Type II RIMS multipliers for “Final-demand employment”¹² for the construction and communications equipment sectors.¹³ These RIMS II multipliers incorporate direct, indirect and induced employment impacts. A recent study by Credit Suisse reported that between 2002 and 2010 the average share of capital spending on equipment relative to total capital spending by wireless carriers was 44 percent.¹⁴ We estimate the employment impacts of the capital spending shown in Table 1. Applying this approach to current data, we calculate a weighted average of Construction (56%) and Broadcasting and Communications Equipment (44%) Type II multipliers (20.4 jobs for every \$1 million invested). We estimate that private sector capital spending associated with the build out and development of 300 MHz of spectrum for mobile broadband will generate an average of more than 300,000 jobs throughout the economy over five years. See Table 2.

Economic Output

We also estimate the increase in GDP from the incremental capital investment described above using RIMS II multipliers obtained from the BEA. We find that capital investments stimulated by newly released spectrum will increase GDP significantly. The reassignment of 300 MHz will increase GDP by \$16.6 billion in the first year of the five-year period, rising to an \$81.8 billion annual increase by the final year. Over the five-year period, we estimate a total impact on domestic output of more than \$230 billion. This result will require no contribution by the U.S. Treasury and is likely just the tip of the iceberg, in terms of economic benefits. See Table 2.

¹² RIMS II Online Order and Delivery System <<https://www.bea.gov/regional/rim/rimii/help.aspx>>.

¹³ See e.g., Hazlett et. al. (2004); Eisenach, Singer and West (2009); Crandall and Singer, (2010); Beard, Ford and Kim (2010).

¹⁴ Credit Suisse (2011).

Table 2: Five-Year Impact of Spectrum Reassignment on GDP and Employment

	Multiplier	Year 1	Year 2	Year 3	Year 4	Year 5	Years 1 - 5	
							Total	Average
Build out Capital Spending (\$ million)		\$5,395	\$5,803	\$13,348	\$24,264	\$26,568	\$75,377	\$15,075
Change in GDP Output (\$ million)	3.0792	\$16,612	\$17,868	\$41,101	\$74,716	\$81,810	\$232,106	\$46,421
Change in Employment (number of jobs)	20.4053	110,080	118,405	272,362	495,120	542,129	n/a	307,619
Notes/Sources:								
1/ Output and employment multipliers from US Bureau of Economic Analysis, Regional Input-Output Modeling System (RIMS II), 2002 U.S. Benchmark Input-Output data and 2008 Regional Data Multipliers for 48 Contiguous States (Requested on 7/6/2011). Final-demand multipliers used are weighted average of <i>Construction</i> (56%) and <i>Broadcasting and Communications Equipment</i> (44%) Type II multipliers. See average equipment to capital expenditures ratio 2002 - 2010 from "Global Wireless Capex Survey - A multi-year spending cycle," Credit Suisse, July 2011 at 8 ; Robert W. Crandall and Hal J. Singer, "The Economic Impact of Broadband Investment" (2010) at 25-26.								
2/ Build out capital spending estimated based on CTIA's Wireless Industry and Investment Build-Out Report (May 2011), p. 21, Table 6; Hazlett et al., "Sending the Right Signals: Promoting Competition Through Telecommunications Reform," A Report to the U.S. Chamber of Commerce, September 22, 2004, p. 103. Capital spending estimates following mid-1990s PCS licensing, adjusted by Producer Price Index for Broadcast and Wireless Communications industry (BLS).								

The Effects of Ongoing Maintenance and Upgrade Capital Spending

Established wireless networks require continuous capital spending on maintenance (e.g., replacement equipment and spares) and upgrade equipment (e.g., current carrier upgrades to fourth generation networks or 4G). One important economic contribution of the FCC's spectrum proposal is that it will generate economic benefits not only during the build out period, as we have described above, but also over the long run as additional capital is invested in maintenance and network upgrades. We estimate required maintenance and upgrade capital spending based on reported capital spending in the period 2002–2004. By 2002, the wireless industry had deployed most of the PCS spectrum, with the notable exception of the licenses held by NextWave. Uncertainty regarding the NextWave licenses was ultimately resolved in 2004, and in later years the FCC auctioned off additional spectrum for mobile services. Assuming that capital spending during the period 2002–2004 was predominantly for maintenance and upgrades, as opposed to the deployment of new spectrum, we interpret average annual capital spending during this period of \$16.5 billion as a reasonable estimate of long-run maintenance and upgrade capital spending for the 300 MHz of spectrum the FCC is currently proposing to reassign. Based on the multiplier approach described above, we estimate that additional annual capital spending of \$16.5 billion would generate an additional \$50 billion in GDP annually and more than 330,000 new jobs.

The FCC's Proposal to Reassign an Additional 200 MHz

In the 2010 Broadband Plan, the FCC proposed reassigning a total of 500 MHz to mobile broadband over 10 years. We have described in detail the impact of reassigning 300 MHz within five years as the FCC proposed. The additional 200 MHz of spectrum that the FCC proposes to reassign to mobile broadband also would stimulate considerable capital spending, with consequent benefits for employment and GDP.

Based on our analysis of capital spending associated with the PCS spectrum, we estimate that an additional 200 MHz of spectrum would stimulate approximately \$50 billion in capital spending to deploy the spectrum for the provision of mobile broadband over a five-year period subsequent to the reassignment of 300 MHz of spectrum discussed above. This additional capital spending would generate an additional \$155 billion in GDP and create an average of more than 200,000 jobs over a five-year build out period, based on the employment and output multipliers described above.

4. SPILLOVER EFFECTS

Our estimates of employment and GDP gains from investment to develop 300 MHz of additional spectrum are only one component of total economic benefits. We do not account for spillover effects from new mobile broadband goods and services. The multiplier effects we have described capture the impact additional investment in new spectrum will have on the U.S. economy, based on measurements of actual relationships between sectors of the economy. In other words, the model captures the effect on economic output (GDP) and employment for products and services that already exist. However, the additional spectrum will also have important positive effects on innovation and the development of new goods and services. Deployment of the new spectrum will facilitate the development of goods and services that are currently in development, such as new software applications, new mobile devices and new healthcare applications. Additional spectrum for mobile broadband will also spur the development and commercialization of new products and services that may be difficult for most of us to imagine at the present. These new wireless products and services likely will change the way people work and play, change economic relationships, lead to productivity gains and ultimately boost employment and GDP. The effect that investment has on productivity, innovation and the commercialization of new products is typically called the spillover effect. Because spillover effects are the consequence of economic relationships that don't exist at the present, it's very difficult to project the size of these effects. Several economists have studied historic spillover effects associated with investments in information technology and telecommunications infrastructure. For example, Crandall, Lehr and Litan (2007) estimate that a one percent increase in broadband penetration would generate approximately 300,000 new jobs.¹⁵ In addition, Jorgenson, Ho, and Stiroh (2008) report that one-third of the growth in labor productivity from 2000 to 2006 can be attributed to information technology and telecommunications.¹⁶ Given documented economic impacts of spillover effects, it seems likely that the spillover effects from the reassignment of 300 MHz of spectrum to mobile broadband will exceed, by a considerable margin, the multiplier effects that we present here.

5. CONCLUSION

As the FCC has concluded, mobile broadband is a critical platform for future innovation. The U.S. wireless industry currently faces severe spectrum constraints, limiting the ability of companies to develop new mobile broadband products and services. By facilitating the reallocation of underutilized spectrum,

¹⁵ Crandall, Lehr and Litan (2007).

¹⁶ Jorgenson, Dale, Mun Ho, and Kevin Stiroh, "A Retrospective Look at the U.S. Productivity Growth Resurgence," *Journal of Economic Perspectives*, Volume 22, Number 1 (2008) pp. 3-24.

policymakers can create a favorable environment for private sector investment in critical wireless infrastructure that will create jobs, spur demand and encourage innovation. However, the economic impacts from capital spending to build out additional spectrum for mobile broadband, which we report in this paper, represent only the tip of the iceberg in terms of long-run economic benefits. A more extensive and robust mobile broadband network will generate considerable spillover effects as firms create new and innovative products and services. The sooner that spectrum is reassigned to mobile broadband, the sooner investment capital will be deployed. A delay in the reassignment will mean a delay in private sector investment and job creation.