Accelerated Wireless
Broadband Infrastructure
Deployment:

Impact on
GDP & Employment
2009–2010

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December 24, 2008
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1. EXECUTIVE SUMMARY

Because of current economic conditions, President-elect Barack Obama has said that his Administration’s major goal will be a stimulus package targeting job growth. Specifically, the President-elect’s Transition Team is looking for key sectors of the economy that can, with a relatively small amount of financial stimulus, yield significant and rapid increases in economic growth and employment. The wireless broadband sector of the Telecommunications-Information-Entertainment (T-I-E) Industry can deliver both of these economic benefits over the next two years, 2009-2010.

This research paper, undertaken with the cooperation of numerous wireless service providers and those deploying broadband infrastructure, estimates that new wireless broadband investments of $17.4 billion will, within 24 months of making this additional investment, increase Gross Domestic Product (GDP) by 0.9% to 1.3%, which translates in dollar terms to $126.3 billion to $184.1 billion, and will result in an increase of between 4.5 million and 6.3 million jobs. The seven-to-tenfold increase in GDP due to new investment in wireless broadband networks is achievable because of both the DIRECT and also the INDIRECT effects these additional capital expenditures will have on the nation’s overall economic growth.

By investing in wireless broadband access infrastructure, both jobs and income are increased, not only by the direct investment in building new wireless towers and modifying existing towers, thereby expanding existing network capacity, speed, and reliability, but also by the indirect benefits of filling coverage holes and providing wireless broadband services to more of the U.S. The resulting improved wireless broadband access can create new businesses based on the availability of faster Internet connections, existing organizations can reap gains in efficiency and will identify new sources of revenue, health and public safety services can be enhanced and made available to a wider audience, and consumers can search online more effectively for goods, services, jobs, and educational opportunities.

The ability to deploy wireless systems and expand wireless broadband service depends on the availability of sites for the construction and placement of towers and transmitters. However, wireless carriers face a significant problem of many zoning authorities failing to resolve wireless tower site applications within a reasonable period of time. These delays or inaction substantially impede wireless build out. CTIA-The Wireless Association® (CTIA) has compiled data on cell site backlogs from members who have more than 3,300 applications pending before local jurisdictions. According to members interviewed for this report, this represents a “bottleneck” that, if removed, would result in a “flood” of “shovel ready” new construction almost immediately. For this reason, in July 2008 CTIA filed a Petition for Declaratory Ruling with the Federal Communications Commission seeking, inter alia, a reasonable “shot clock” for local zoning authorities to act on tower site applications.1

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1 In the Matter of Petition for Declaratory Ruling to Clarify Provisions of Section 332(c)(7)(B) to Ensure Timely Siting Review and to Preempt under Section 253 State and Local Ordinances That Classify All
A grant of CTIA’s tower site Petition, along with more rapid approval by the FCC of related infrastructure permissions, would eliminate a significant barrier to wireless infrastructure investment and, as described further herein, enable the realization of additional wireless broadband investments of $17.4 billion and further direct and indirect economic benefits. In addition, action by the Chief of the Wireless Telecommunications Bureau on delegated authority removing the backlog of pending applications that have been referred to the Commission for review pursuant to the National Environmental Policy Act (NEPA) would also help expedite the construction or the augmentation of existing facilities.

2. OVERVIEW: WIRELESS BROADBAND, GDP, & JOBS

Substantial economic benefits associated with greater investment in wireless broadband infrastructure can be generated not only by the direct economic effect of increased capital spending, but also from the indirect “follow-on” effects associated with the initial investment. This “indirect” effect is similar to building a roadway which not only generates jobs and income for the builders of the road, but also provides opportunities for others to create new businesses and homes along the roadway.

Using conservative estimates, along with recently published empirical estimates of the positive impact of broadband access, this research describes the positive direct effects that will flow from facilitating immediate investment in wireless broadband infrastructure by expediting the approval process for towers and cell sites, and outlines even stronger indirect effects caused by the types of benefits noted above. Table 1 provides highlights of the direct, indirect, and total effects on GDP and employment based on low and moderate levels of investment multipliers over the 24 months following the beginning of construction.

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### Table 1. Economic Impact on GDP and Employment of Additional Wireless Capital Expenditures

<table>
<thead>
<tr>
<th></th>
<th>6 mos.</th>
<th>12 mos.</th>
<th>24 mos.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct Effects on GDP</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Required Incremental Investment in Wireless Broadband Infrastructure</td>
<td>$ 4.4 bil.</td>
<td>$ 8.7 bil.</td>
<td>$ 17.4 bil.</td>
</tr>
<tr>
<td>Cumulative Change with Low Multiplier Effect</td>
<td>0.06%</td>
<td>0.11%</td>
<td>0.23%</td>
</tr>
<tr>
<td>Cumulative Change with Moderate Multiplier Effect</td>
<td>0.07%</td>
<td>0.15%</td>
<td>0.30%</td>
</tr>
<tr>
<td><strong>Indirect Effects on GDP</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Estimate of Cumulative Change</td>
<td>0.21%</td>
<td>0.43%</td>
<td>0.65%</td>
</tr>
<tr>
<td>Moderate Estimate of Cumulative Change</td>
<td>0.32%</td>
<td>0.65%</td>
<td>0.98%</td>
</tr>
<tr>
<td><strong>Total Effects on GDP</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Estimate of Cumulative Change</td>
<td>0.27%</td>
<td>0.54%</td>
<td>0.88%</td>
</tr>
<tr>
<td>Moderate Estimate of Cumulative Change</td>
<td>0.40%</td>
<td>0.80%</td>
<td>1.28%</td>
</tr>
<tr>
<td>Low Estimate of $ Change in GDP</td>
<td>$ 39.3 bil.</td>
<td>$ 78.6 bil.</td>
<td>$ 126.3 bil.</td>
</tr>
<tr>
<td>Moderate Estimate of $ Change in GDP</td>
<td>$ 57.6 bil.</td>
<td>$ 115.3 bil.</td>
<td>$ 184.1 bil.</td>
</tr>
</tbody>
</table>

**Effects on Total Employment**

|                                    |         |         |         |
| Low Estimate of Growth in Employment | 0.83%  | 1.65%   | 3.30%   |
| Moderate Estimate of Growth in Employment | 1.15%  | 2.30%   | 4.60%   |
| Low Estimate of Change in the Number of People Employed | 1.1 mil. | 2.3 mil. | 4.5 mil. |
| Moderate Estimate of Change in the Number of People Employed | 1.6 mil. | 3.2 mil. | 6.3 mil. |

The seven-to-tenfold increase in GDP, compared to the initial incremental investment of $17.4 billion in wireless broadband networks, is created by the macro-economic “multiplier effect,” popularized by John Maynard Keynes. Income and employment generation are defined and explained in terms of how a $17.4 billion investment in
infrastructure causes a substantially greater increase in an economy’s output through both “direct” and “indirect” effects on the economy. The direct effect on GDP is caused by the increased jobs and income associated with constructing new cell towers and expanding the capacity, reliability, and availability of existing wireless networks, giving even more Americans access to new applications and services to the nation as a whole. As noted in Table 1 above, the direct benefits are substantial and will increase GDP cumulatively between 0.23% and 0.30% over a 2-year period.

In addition to the direct effects, Table 1 outlines even larger cumulative gains of 0.65% to 0.98% in GDP from indirect effects, such as increased revenues and lower costs for businesses, as well as greater online capabilities for consumers, for example job searches, working from home, education via online distance learning services, healthcare and public safety, et al. These indirect benefits are the by-product of what economists call “positive externalities,” which indicate that society as a whole benefits from a nationwide wireless broadband to the person.

Recent research by Dr. Harold Furchgott-Roth, “The Wireless Services Sector: A Key to Economic Growth in America,” includes data from sources also used in this research and documents the many positive contributions made by the wireless services sector to society at large, concluding that “the wireless services industry is a large and growing segment of the American economy; and wireless services are the hub of the wheel of a much larger set of industries that contribute to American economic growth.”

Economists have studied the major benefits of network upgrades and the consequent positive externalities. Most recently, Kidokoro (2007) developed a theoretical model of how competing providers of Internet access can generate positive externalities by offering faster access speeds. In this model, the positive externalities of the network are derived from greater “information variety” that can be created due to faster Internet access. Thus, the model captures some of the key aspects of how wireless broadband Internet access can spawn new businesses, more effective shopping and delivery services, new work environments such as telecommuting, increased educational opportunities via distance learning, etc., that benefit all areas of society. In addition, the model demonstrates how competition between numerous Internet access providers can lead to faster access speeds relative to a situation where a monopolist controls the entire market.

**Positive Externalities**


Ovum’s report of 2008 projects $860 billion in nationwide cost savings and additional revenue during the period from 2005 to 2016, the benefits of increased wireless broadband usage will have, and will continue to have, from productivity gains, primarily in the following areas:
• Improved management of inventory and other business resources
• Efficiency gains in delivering health care services
• Automating field service and fleet management
• Reduced inventory losses due to more timely and accurate information
• Increased efficiency and automation of sales force activities
• Cost savings related to replacing office-based land lines with wireless communication devices

Using the Ovum report, along with the Furchgott-Roth data, as starting points, it is possible to see the value creation stemming from positive externalities when increased wireless broadband access is deployed. Some of these positive externalities are presented below:

• Increased opportunities for retailing and delivery services due to greater online shopping (particularly in rural areas where the quantity and variety of stores might be limited).
• More people may be likely to telecommute, thus alleviating traffic congestion, reducing pollution, and reducing gasoline consumption.
• Greater educational opportunities via increased enrollment in online distance-learning programs (via traditional colleges or adult-oriented schools, such as the University of Phoenix, etc.).
• Better matching of employee skills with employer needs via online job search services, such as monster.com.
• Improved public safety through faster communication of emergencies to the public and via more effective monitoring of water pipes, natural gas pipelines, etc.
• Introduction of new telemetry-based business solutions such as point-of-sale applications, “white van” tracking services, remote monitoring of business processes and systems.
• More effective management of financial resources due to increased usage of electronic banking services such as online bill payment systems, online searches for low-cost loans and credit cards.
• In rural areas, online (and real-time) weather monitoring and farming information can provide timely and more in-depth information that can lead to increased crop yields and more efficient farms/ranches.

There are also numerous online business success stories, related to how increased Internet usage spawned new businesses, for example Amazon.com and online educational service companies such as The Apollo Group, which operates the University of Phoenix:

Amazon.com (AMZN) has risen more than 30-fold from May 1997 until December 2008. This translates into a Cumulative Average Growth Rate (CAGR) of 36.3%.

Apollo Group (APOL) has risen more than 64-fold from January 1995 until December 2008. This translates into a CAGR of 34.7%.
3. PRIOR RESEARCH

While there have been numerous empirical studies of the economic impact of information technology (IT) and telecommunications spending, much less research has been conducted on broadband access to IT innovations such as the Internet. For example, both Roller and Waverman (2001) and Waverman, Meschi, and Fuss (2005) find that greater investment in telecommunications infrastructure can yield a 0.59 percentage point increase in GDP growth across developed countries and also developing nations. In addition, Jorgenson (2001) examines how IT spending has enhanced economic growth and the overall quality of life, with a primary focus on how these investments have lowered the cost of capital and production costs, as well as increased productivity. Based on a survey of 2,065 U.S. firms, Varian, Litan, Elder, and Shutter (2002) focus on the impact of investments in Internet business solutions and find that businesses expect to reap cost savings and increased revenue of over $450 billion during 2001-2010. This translates into an annual gain in productivity of 0.43 percentage points.

In sum, although these studies do not directly examine the effects of broadband access, they do confirm and support the hypothesis that increased IT and telecommunications spending has had a significant and positive impact on economies around the world.

In addition to the above studies, empirical research on the specific impact of broadband internet access has begun to appear in the literature. An early paper by Crandall and Jackson (2001) estimated annual benefits of up to $500 billion (in terms of GDP) that would accrue to consumers and businesses because of increased access to broadband internet services. More recently, the U.S. Department of Commerce (2006) commissioned a study of the effect that broadband deployment will have on employment, salaries, new business formation, and other macroeconomic variables. Using data at the zip code level and regression analysis, the authors found a statistically and economically significant cumulative gain of 1.0-1.4% in the growth of jobs during 1998-2002. This translates into an annualized increase of 0.33-0.46 percentage points in employment due to greater broadband access.

Crandall, Lehr, and Litan (2007) also use regression analysis to examine the effect that the proliferation of broadband has on the growth in employment and GDP at the state level (analyzed across 48 states). They find that the marginal effect of wider broadband access on employment can result in a 0.22-0.30 percentage point increase in annual job growth. Thus, a 3 percentage point increase in the rate of broadband penetration could yield an additional 880,000 jobs. More recently, a study commissioned by the Sacramento Regional Research Institute (SRRI) studied the impact of broadband access at the county level by using data from 39 counties in California. The SRRI authors employ a methodology similar to the one used by the Department of Commerce (2006) and Crandall, Lehr, and Jackson (2007) and find results that are consistent with these other studies. For example, the SRRI report indicates that there are annualized employment gains of 0.10-0.29 percentage points which could translate into 1.8 million new jobs and $132 billion of additional payroll income in California during 2005-2015.
Overall, the studies have demonstrated that increased broadband access can lead to statistically significant and economically meaningful positive effects on economic activity. Although Internet access has been around since the 1990s, the benefits of the Internet have become much stronger during the current decade due to greater access to broadband-based Internet service. As Crandall, Lehr, and Litan (2007) observed:

“Broadband services offering at least an order of magnitude improvement over dial-up data rates and always-on connectivity were needed for the Internet to realize its true potential and to make it feasible to better realize the potential of embedded information communications technology (ICT) investments. The emergence of ICT-powered enhanced healthcare, telecommuting, and realization of economic growth benefits in communities in rural areas (the “death of distance”) depend on the widespread deployment of broadband services.”

To date, the research not only provides a better understanding of the economic impact of broadband access, it also enables us to quantify a forward-looking economic growth estimate which combines the direct “multiplier” effects of additional wireless capital expenditures with the indirect “externality” effects based on all the benefits noted above that follow from an expansion of wireless broadband services.

4. EMPIRICAL METHODS USED

In order to compute the direct and indirect effects of wireless broadband investment on economic activity, we used multiple empirical methods. Although alternative methods are used to estimate the investment multiplier, as well as the benefits of the positive externalities derived from wireless broadband, and the related impact on job growth, all of these empirical techniques provide a consistent picture of how broadband access can help stimulate economic output and employment.

(1) Estimating the Direct Effect on GDP of Wireless Broadband Capital Expenditures

To estimate the “direct” effect on GDP of wireless broadband spending, two important inputs are needed: 1) A forecast of increased wireless broadband capital expenditures; and 2) an appropriate investment multiplier.

The first step is to forecast capital expenditures. To do this, we inquired within the wireless industry and obtained the Personal Communications Industry Association’s (PCIA) current forecasts of increased spending on cell towers, existing sites, and other wireless facilities, if tower siting approval mechanisms and time periods were given greater regulatory clarity and certainty. Item 1 in Table 2 provides details of the PCIA forecasts of $11.5 billion in new wireless investments, if regulatory relief is provided by the FCC as requested in CTIA’s Petition for Declaratory Ruling.

Due in large part to current economic conditions, wireless service providers are cutting back, as opposed to increasing, capital expenditures (see UBS research report, December
According to UBS, publicly traded national wireless carriers are expected to decrease their collective capital spending in 2009 by 21% from 2006’s level. In addition, the U.S. Census data on Annual Capital Expenditures (which covers both public and private wireless companies) has shown large cyclical swings that coincide with overall macroeconomic conditions. However, wireless broadband infrastructure spending could be accelerated if President-elect Obama’s Administration encourages and supports action by the FCC to speed up wireless infrastructure construction and broadband deployment.

Figure 1 illustrates the historical trends in the U.S. Census and the UBS research capital expenditure data. During the last economic downturn, wireless investments dropped nearly 18% from 2000 to 2003 and, as noted, UBS is projecting a 21% decline in wireless capital expenditures by the publicly traded nationwide wireless providers from 2006 to 2009. This information can help quantify the magnitude of “countercyclical stimulus” that would be needed to offset the wireless companies’ projected cutbacks in investment spending during 2009. For example, we estimate that a total of $5.88 billion is required to completely offset these cutbacks in capital spending. This figure is obtained by multiplying the expected 21% drop in spending by the 2006 industry-wide capital expenditures of $28.0 billion (see Item 2 of Table 2 for more details on this calculation).

Given the PCIA figures and our internal forecasts of wireless broadband spending, we simply sum these two forecasts to obtain an estimate of $17.4 billion for the total incremental wireless broadband capital expenditures. As can be seen in Item 3 of Table 2, this figure is the sum of lines (A) and (B), which represent the PCIA’s and our internal spending forecasts, respectively. These capital investments are then assumed to be spent evenly over the next two years.

To assess the full impact of this $17.4 billion of wireless broadband investment, a Keynesian multiplier is needed to quantify the ripple effects of greater investment on the spending behavior of other firms that provide goods and services to the wireless broadband sector. Thus, we use two different multipliers in order to provide a range of possible values for the direct effect of additional wireless capital expenditures. For example, the “Low” multiplier of 1.91 is based on the Bureau of Economic Analysis (BEA) investment multiplier for the Communication, Transportation, and Utilities Industries. In addition, a “Moderate” multiplier of 2.49 is based on the BEA’s investment multiplier for regional construction. This alternative multiplier was employed because one can view the direct investment in building wireless cell towers and other infrastructure as a set of regional construction projects.

Once forecasts of wireless capital expenditures and appropriate investment multipliers have been obtained, an estimate can be made regarding how GDP will be affected by this increased direct investment by multiplying the total incremental wireless broadband capital expenditures by the investment multipliers. Item 4 in Table 2 provides the details for these calculations, and shows that the total direct effect of wireless broadband spending is expected to be between $33.2 and $43.2 billion.
(2) Estimating the Indirect Effect on GDP of Wireless Broadband Capital Expenditures

To estimate the “indirect” effects associated with all the other economic benefits derived from greater productivity, increased revenue opportunities, a wider variety and easier accessibility of goods and services, improved information, etc., we rely upon previous studies of Internet and broadband usage. In particular, we use the annual productivity gains of 0.43% of GDP estimated in Varian, et al. (2002), and the 0.65% annual productivity enhancements found in Ovum (2008) to provide “Low” and “Moderate” estimates of the indirect effects of additional wireless broadband spending on GDP.

These annual figures are then compounded over the 6-24 month forecast period to come up with cumulative gains in GDP that would be attributable to indirect benefits of the additional $17.4 billion in wireless broadband investments. Item 5 in Table 2 explains the calculations of these indirect benefits.

(3) Estimating the Total Effect on GDP of Wireless Broadband Capital Expenditures

As shown in Item 6 of Table 2, the “total” effect of the projected increase in wireless broadband spending is a simple sum of the direct and indirect effects on GDP (and employment).

(4) Estimating the Impact of Additional Wireless Broadband Capital Expenditures on Total Employment

In order to examine the wireless impact of broadband spending on employment, we rely upon the multivariate regression approach that has been used by the U.S. Department of Commerce (2006), along with authors Crandall, et al. (2007), and the SRRI authors (2007). All three of these studies use regression analysis in order to estimate the impact of broadband usage on various economic factors, including employment, personal income, business formation, GDP, etc.

To demonstrate how this regression approach works, we present below a brief description of the model used in the SRRI report to identify the effects of broadband usage on employment, wages and salaries, and business formation. The estimate of the parameter $\alpha_i$ in the following ordinary least squares (OLS) regression equation is equal to the average growth rate, $g^*$, for each individual county in California during 2001-2006.

$$ g_{it} = \alpha_i + \delta_t + X_{it}\beta + \gamma BB_{it} + e_{it} $$

This regression model indicates that the quarterly growth rate of employment in a particular county and during a specific quarter, $g_{it}$, is a function of the county’s average growth rate, $\alpha_i$, a “dummy” variable to control for trends over time, $\delta_t$, other “control” variables such as personal income levels, $X_{it}$, and the effect of broadband “penetration,”
BB_i,t, (as measured by the parameter labeled, $\gamma$, or “gamma”). This $\gamma$ parameter measures the marginal effect of the penetration of broadband on job growth (holding constant all other factors in the model). Thus the main area of interest in the Department of Commerce, Crandall et al., and SRRI studies is the statistical and economic significance of gamma ($\gamma$). All three studies report significant positive estimates for gamma, ranging from 0.1% to 0.5% on an annualized basis. They also suggest that a 10% increase in nationwide broadband access can lead to a 1% to 5% increase in employment.

In sum, these empirical analyses provide strong evidence that greater broadband access leads faster job growth.

To obtain “Low” and “Moderate” estimates of the impact of broadband access on employment, we used the Commerce Department’s annualized estimates for gamma of 0.33% and 0.46%. The Commerce Department’s parameters were chosen because they were based on an extensive database that segmented the nation’s level of broadband access at the zip code level, thus yielding over 22,000 data points. These gamma estimates are then multiplied by Ovum’s (2008) forecast of increased broadband access of five (5) percentage points per year during 2009-2010 to produce the expected impact on job growth during this two-year period. We assume that this increased penetration rate of broadband access will occur evenly over the forecast period. Item 7 of Table 3 provides the details on these estimates.

5. EMPIRICAL RESULTS

Table 3 provides the estimated effects on GDP and employment due to increased spending on wireless broadband infrastructure. As described in the previous section’s discussion of Table 2, the information displayed in Table 3 begins with estimates of the direct effects on GDP of increased wireless spending over a 24-month period and then reports the indirect and total effects in subsequent rows. The final section of Table 3 provides estimates of the impact on employment due to increased wireless capital expenditures.

As noted in the Introduction, and summarized in Table 1, a $17.4 billion investment in increased wireless broadband infrastructure can have a large and relatively rapid positive influence on the nation’s levels of GDP and employment. For example, additional wireless broadband investments can increase GDP by 0.88% to 1.28% (a gain of $126.3 billion to $184.1 billion in dollar terms) within two years of the additional investment. In turn, this investment will also create 4.5 million and 6.3 million additional jobs over the two-year forecast period 2009-2010. The data thus add to the overview of the wireless sector concisely outlined in the Furchgott-Roth report.

This seven-to-tenfold increase in GDP (when compared to the initial incremental investment of $17.4 billion in wireless broadband networks) is achievable because of the direct and indirect effects of these additional capital expenditures. Table 3 shows that the direct effects of increased wireless spending can raise GDP between 0.23 and 0.30 percentages over a two-year period. In addition, Table 3 reports an even bigger gain in
GDP of between 0.65 and 0.98 percentage points because of all the positive indirect effects associated with making wireless broadband service more widely available.

Overall, the results suggest that additional investment in wireless broadband infrastructure can yield significant and economically meaningful gains in GDP and employment.

6. CONCLUSIONS

• An economic goal of President-elect Obama’s Administration should be to bring high speed wireless broadband services to all Americans using as a model the deployment of the public switched telecommunications network (PSTN), which provided ubiquitous, low cost services to all, and the Interstate Highway System, both of which brought enormous economic and employment benefits to the U.S. In order to accelerate the much needed economic stimulus, the new Administration should remove economic and regulatory bottlenecks in order to simulate investment in “shovel ready” new infrastructure. A first step in relieving a critical regulatory bottleneck would be FCC action granting the CTIA Petition for Declaratory Ruling that requests a reasonable “shot clock” for local zoning authorities to act on wireless industry tower siting applications. Action on pending applications that have been referred to the FCC because of NEPA review would also help expedite the construction and/or augmentation of existing facilities.

• Broadband wireless brings both bandwidth and speed, which translate into value, economic growth, and job opportunities.

• President-elect Obama’s Administration can assist in the construction of infrastructure and the more rapid deployment of broadband services throughout the nation by encouraging the FCC to take action with respect to the bottleneck in cell site approvals.

• Rapid deployment of wireless broadband services will provide an immediate economic stimulus to a wide array of business, governmental, educational, social and entertainment, healthcare, and law enforcement and public safety activities. This build out also will contribute to growth in jobs and incomes while also assisting in the country’s much needed economic recovery during the next two years.

• Additional wireless broadband investment in infrastructure will contribute to the creation of between 4.5 million and 6.3 million jobs over the next two years.

• Jobs and income benefits will accrue to the U.S. economy as a whole because improved wireless broadband will stimulate new business activity due to the availability of faster and more robust Internet connections. Existing business and other organizations will reap gains in efficiency, and will identify new sources of revenue; public safety and health care can be enhanced and brought to more Americans; educational opportunities will be more easily available; work from home will be enabled thus aiding energy
conservation; and vital infrastructures will be protected by broadband wireless-dependent early warning and sensing equipment.
Reference Materials


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Dr. Pearce founded Information Age Economics in 1979 after a nine-year senior level policy career in the US Government. He was one of the prime architects of pro-competitive public policies at the Federal Communications Commission where he helped lay the foundation of a new information era, serving as Chief Economist for two Chairmen. Dr. Pearce next became chief economist of the Subcommittee on Telecommunications, US House of Representatives, and then joined the U.S. Office of Telecommunications Policy in the Executive Office of the President.

Since leaving the government, Dr. Pearce has provided professional services to telecommunications, wireless, satellite, cable TV, radio and TV broadcasting, movie and program production companies, along with software and equipment manufacturers. He has also consulted with a wide variety of government organizations at the international, federal, state, and local levels, and has assisted clients in the U.S. and overseas with negotiations on privatization’s and appropriate regulatory structures, antitrust issues, spectrum auctions, mergers and acquisitions, appraisals and valuations, franchises, and service rates.

He was educated at The London School of Economics and Political Science, University of London, and Indiana University.

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Dr. Pagano is an Associate Professor of Finance at Villanova University. Professor Pagano has conducted several empirical analyses related to various issues in market microstructure, financial institution management, risk management, cost of capital estimation, and interest rate determination. He has published in numerous finance journals such as the Journal of Financial Economics, Journal of Banking and Finance, Journal of International Money and Finance, Journal of Portfolio Management, and the Financial Analysts Journal. Professor Pagano serves on the editorial boards of two academic journals, the International Journal of Managerial Finance and the Review of Pacific Basin Financial Markets and Policies. Professor Pagano has also been a Fulbright Scholar at the University of Costa Rica, a Visiting Professor at the University of Otago in New Zealand, and has received awards for both teaching excellence and academic scholarship.

Prior to earning his doctorate and joining the Villanova University faculty, Professor Pagano spent over 10 years in the financial services industry. He holds the Chartered Financial Analyst (CFA®) designation and has experience both in commercial lending activities at Citibank and in investment valuation analysis at a financial consulting firm,
International Capital Markets Corp., as well as Reuters PLC. Professor Pagano has been a consultant to several companies including Citibank, PaineWebber, Fidelity Investments, GTE Investments, Philadelphia Suburban Corp., Aqua America, and Bank Julius Baer. Professor Pagano is a commentator on current market structure issues and has been frequently quoted in various media sources such as the Wall Street Journal, New York Times, Financial Times, CNBC, Bloomberg TV, and Bloomberg Radio.
### Table 2.
**Key Assumptions related to the Economic Impact Estimates:**

1. **Cumulative Additional Wireless Broadband Capital Expenditures:**
   - New Cell Tower Construction: 0.488
   - New Investment in Collocated / Existing Towers: 5.250
   - Capital Investments in Wireless Facilities: 5.738
   - **Line (A): Total New Wireless Broadband Investments** = 11.476
     This amount is then divided evenly over the 24 mos.

2. **Wireless Capex to offset Business Cycle downturn:**
   - Change in Capex for Nationwide Wireless Companies (2006-2009): -21.0%
   - Total Wireless Capex (Public and Private) during 2006 ($ bil.): 28.0
   - **Line (B): Capex Decline due to UBS' Projected Cutbacks** ($ bil.) = 5.880
     This amount is then divided evenly over the 24 mos.

3. **Total Incremental Wireless Broadband Capital Expenditures:**
   - **Line (C): equals the Sum of Lines (A) and (B) ($ bil.)** = 17.356
     This amount is then divided evenly over the 24 mos.

4. **Investment Multiplier for Direct Effects of Wireless Capex on GDP:**
   - Total Direct Effect on GDP of Capex based on Low Multiplier: 33.150
     This amount is then divided evenly over the 24 mos.
   - Total Direct Effect on GDP of Capex based on Moderate Multiplier: 43.216
     This amount is then divided evenly over the 24 mos.
Table 2.
Key Assumptions related to the Economic Impact Estimates: *(continued)*

5. *Indirect Effects of Wireless Capex on GDP caused by Positive Externalities:*

<table>
<thead>
<tr>
<th>Assumptions</th>
<th>Low Estimate of Annualized % Chg. in GDP (Varian et al. est.)</th>
<th>Moderate Estimate of Annualized % Chg. in GDP (Ovum estimate)</th>
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<tr>
<td></td>
<td>0.43%</td>
<td>0.65%</td>
</tr>
<tr>
<td></td>
<td>6 mos. 12 mos. 24 mos.</td>
<td>6 mos. 12 mos. 24 mos.</td>
</tr>
<tr>
<td></td>
<td>0.21% 0.43% 0.65%</td>
<td>0.32% 0.65% 0.98%</td>
</tr>
</tbody>
</table>

*Note:* The Estimated Dollar Chg. In GDP for the above estimates are computed by multiplying the above percentages by 2008 Q3 GDP of $14,420.5 bil.

6. *Total Effects on GDP of Increased Broadband Usage due to Additional Wireless Capex:*

The Total Effects are the sums of the Direct and Indirect Effects on GDP due to the Additional Wireless Capex noted in Line (C) above.

7. *Impact of Additional Wireless Capex on Total U.S. Employment (in mil. of jobs or %)*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity of Employment Growth to Broadband Penetration Rate</td>
<td>0.0033</td>
<td>5.0% 6 mos. 12 mos. 24 mos.</td>
<td>0.83% 1.65% 3.30%</td>
</tr>
<tr>
<td>Est. Annual Increase in Broadband Penetration Rate (Ovum, 2008)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity of Employment Growth to Broadband Penetration Rate</td>
<td>0.0046</td>
<td>5.0% 6 mos. 12 mos. 24 mos.</td>
<td></td>
</tr>
<tr>
<td>2008)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>Moderate Estimate of Effect on % Growth in Total Employment</td>
<td>1.15%</td>
<td>2.30%</td>
<td>4.60%</td>
</tr>
</tbody>
</table>

*Note:* The Estimated Growth in the Number of People Employed for the above estimates are computed by multiplying the above percentages by the 2008 Q3 Labor Force of 137.331 mil. workers.
<table>
<thead>
<tr>
<th>Source</th>
<th>6 mos.</th>
<th>12 mos.</th>
<th>24 mos.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCIA (2008)</td>
<td>$2.869</td>
<td>$5.738</td>
<td>$11.476</td>
</tr>
<tr>
<td>UBS (2008), IAE</td>
<td>$1.470</td>
<td>$2.940</td>
<td>$5.880</td>
</tr>
<tr>
<td>BEA (1999)</td>
<td>$8.287</td>
<td>$16.575</td>
<td>$33.150</td>
</tr>
<tr>
<td>Vari et al. (2002)</td>
<td>$30.971</td>
<td>$62.008</td>
<td>$93.112</td>
</tr>
<tr>
<td>Ovum (2008)</td>
<td>$46.791</td>
<td>$93.733</td>
<td>$140.828</td>
</tr>
<tr>
<td>Low Estimate of Cum. % Chg. in nominal GDP</td>
<td>0.21%</td>
<td>0.43%</td>
<td>0.65%</td>
</tr>
<tr>
<td>Moderate Estimate of Cum. % Chg. in nominal GDP</td>
<td>0.32%</td>
<td>0.65%</td>
<td>0.98%</td>
</tr>
<tr>
<td>$39.258</td>
<td>$78.583</td>
<td>$126.262</td>
<td></td>
</tr>
<tr>
<td>$57.595</td>
<td>$115.341</td>
<td>$184.045</td>
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</tr>
<tr>
<td>0.27%</td>
<td>0.54%</td>
<td>0.88%</td>
<td></td>
</tr>
<tr>
<td>0.40%</td>
<td>0.80%</td>
<td>1.28%</td>
<td></td>
</tr>
<tr>
<td>Impact of Additional Wireless Capex on Total U.S. Employment (in mil. of jobs or %)</td>
<td>Source</td>
<td>6 mos.</td>
<td>12 mos.</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Low Estimate of Effect on % Growth in Total Employment</td>
<td>U.S. Commerce (2006)</td>
<td>0.83%</td>
<td>1.65%</td>
</tr>
<tr>
<td>Moderate Estimate of Effect on % Growth in Total Employment</td>
<td>U.S. Commerce (2006)</td>
<td>1.15%</td>
<td>2.30%</td>
</tr>
<tr>
<td>Low Estimate of Change in the Number of People Employed</td>
<td></td>
<td>1.133</td>
<td>2.266</td>
</tr>
<tr>
<td>Moderate Estimate of Change in the Number of People Employed</td>
<td></td>
<td>1.579</td>
<td>3.159</td>
</tr>
</tbody>
</table>

* - Changes in GDP and Employment are based on 2008 Q3 data: $14,420.5 bil. and 137.331 mil., respectively.
Figure 1. Annual Capital Expenditures by Wireless Service Providers

Sources: U.S. Census data, UBS Wireless Industry report