



August 1, 2005

Dear Rural Broadband Study Reader:

A Vision Shared is dedicated to supporting efforts that will enable West Virginia to be a national economic leader in the future. Because much is unknown about the economic impact of providing broadband usage to rural users, A Vision Shared commissioned the Center for Business and Economic Research at Marshall University to complete a rural broadband study. With the findings in, we are now pleased to present this final report entitled *The Residential and Commercial Benefits of Rural Broadband: Evidence from Central Appalachia*.

The availability, access, and ultimate use of broadband in both business and residential settings are critical issues for West Virginia, especially in rural areas. A Vision Shared believes a goal of fully ubiquitous broadband access for the entire state, including transient and nomadic users as well as residential and business users, is the right one for West Virginia's future. In achieving this goal, policy and funding decisions must be made that minimize risks and remain consistent with national technology trends. Policy should allow the private sector to continue to provide for broadband needs and focus support on those areas of the state that are uneconomic to serve by the private sector.

To chart a course forward, the state must understand its current status. Unfortunately, the process of quantifying and qualifying broadband usage in West Virginia is a difficult undertaking. Without conducting an exhaustive and expensive analysis, researchers must sample small subsets of the population and depend on existing federal data that can be both dated and ambiguous. Nevertheless, this study, commissioned by Vision Shared's leadership and overseen by a volunteer Vision Shared steering committee, provides useful data and analysis for providing insights into many aspects of the current 'state of broadband' in our state. This report does not provide all of the answers; rather, it is intended to be used as an important source of information. Seen as an objective resource compiled by economists, this document should be factored into the important dialogue that must take place in order to develop the best strategy to keep West Virginia in the forefront when it comes to the utilization of technology.

The study is especially useful in helping to highlight areas in need of attention. For example, the study presents the fact that even in regions where broadband access is available, subscription is below national averages. This implies that there is a need to educate users on how broadband can be leveraged to increase both business competitiveness and quality of life. The study also provides data demonstrating that broadband access is progressing well in many of West Virginia's urban centers, which would indicate that state initiatives/resources should be focused on rural areas and underserved communities and not on duplicating existing services already being provided by the private sector.

From the study's findings we learned that broadband usage is clearly linked to age and education levels. Thus, the study confirms, from another vantage point, that there are other challenges we as a state continue to face. In essence, this report provides another manifestation of the conditions that must collectively improve in order to bring about economic improvement in the state.

A Vision Shared is future-oriented and is about building a better West Virginia for every citizen. The study offers insights and suggestions for those involved in setting policy regarding broadband. The Vision Shared leadership offers this thoughtful study conducted by Marshall University for



use by those engaged in broadband policy discussions. A cornerstone of A Vision Shared is to bring all viewpoints on any topic to the table. Therefore, A Vision Shared welcomes both careful and objective review of the study and the presentation of other viewpoints on the topic of broadband usage.

In closing, the Vision Shared leadership extends its appreciation to those Vision Shared volunteers who served on the study steering committee for this initiative. The work of these dedicated individuals is a reason for optimism about the future of our state.

On behalf of the Vision Shared Implementation Task Force,

A handwritten signature in black ink, appearing to read "James L. Estep".

James L. Estep  
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H. Stan Cavendish

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Kenneth M. Perdue

# THE RESIDENTIAL AND COMMERCIAL BENEFITS OF RURAL BROADBAND: EVIDENCE FROM CENTRAL APPALACHIA

Final Report

July 2005

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West Virginia  
Development  
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Final Report

July 2005

by

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*The views expressed in this article are those of the authors and do not reflect the official policy or position of Marshall University, its governing bodies, the United States Air Force, Department of Defense, or the U.S. Government.*

## *Executive Summary*

### *Introduction*

Internet access via broadband telecommunications services is widely available throughout much of West Virginia. Indeed, 93 percent of zip codes have access to one or more high speed service providers.<sup>1</sup> Moreover, broadband usage is growing at a blistering rate, with the number of subscribers increasing by well over 50 percent between December 2003 and December 2004 to a total of more than 155 thousand.<sup>2</sup>

Still, there are more than a few rural communities where broadband, high speed services are not available. This fact, combined with the growth in the number internet applications that require relatively high access speeds, has led many rural residents and the policy-makers who represent them question whether current state policies are sufficient in this area. It is within this context that Marshall University's Center for Business and Economic Research (CBER) was asked to measure, as well as possible, the economic benefits achievable through the extension of existing broadband networks into locations where high-speed services are currently unavailable.

### *Study Methodology*

Available broadband benefits its users in a variety of ways. Commercial users derive utility through applications that allow them to increase productivity and lower costs. Government agencies and educational institutions also use high-speed internet applications to lower costs and extend services. Residential users derive increased utility through improved access to a variety of high-speed applications that often relate to entertainment. While government and other institutional usage is important, high speed services are generally already available to would-be users. Therefore the current analysis is focused on the potential benefits to new non-government commercial and residential users.

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<sup>1</sup> Throughout this analysis we adopt the Federal Communication Commission definition of "high speed". This definition includes any service with a one-way speed of at least 200 kbps. The presence of broadband in a zip code does not mean that broadband is universally available within that zip code.

<sup>2</sup> See *High-Speed Services for Internet Access: Status as of December 31, 2004*, Federal Communications Commission, Industry Analysis and Technology Division, Wireline Competition Bureau, July 2005

To capture the potential benefits to new commercial users, the study team engaged in three separate avenues of investigation. First, firm level data were used to investigate productivity differences between firms located in areas with broadband access and firms located in areas where access was unavailable. Next, the study engaged in a county-level four-state analysis of both aggregate and sector-specific wages, under the hypothesis that increases in productivity should yield higher wages. Finally, we engaged in an industry-specific (albeit, qualitative) investigation of firm locations.

The data describing household behaviors and preferences were developed directly through a survey of 600 West Virginia households. These data were supplemented with 2000 U.S. Census data where necessary. The household data lend themselves to a very rich qualitative interpretation. Additionally, the study team statistically modeled both the decision to acquire any form of internet access and the subsequent decision between alternative forms of access.

### *Analytical Results*

With regard to potential commercial benefits, all three analytical paths suggest that high-speed access is important, particularly to firms within the Services and Finance sectors. These conclusions are consistent with previous published research in the field. Indeed, in West Virginia, workers in those two sectors earn between one and two thousand dollars a year more than similar workers when they are located in areas with high speed, broadband access. Moreover, there appear to be a number of industries that simply will not locate in areas where broadband is unavailable.

From a state-wide policy perspective, the results point to an ongoing success rather than any sort of notable failure. The business community and policy-makers alike have correctly contended that broadband telecommunications services can contribute to increased firm productivity. The analysis suggests that broadband *already is* making this contribution and that the vast majority of firms that can benefit are doing so. Accordingly, the aggregate state-wide benefits from extending broadband access to additional commercial users are modest when compared to the benefits already achieved under current state policies.

The analysis of residential usage was also very informative. Approximately 50 percent of the residences surveyed have some form of internet access and of those households that do subscribe to internet services 42 percent do so via broadband. Both figures are below the national averages of 66 percent and 51 percent respectively. This outcome is likely attributable to West Virginia's relatively older population and an observable deficit in educational attainment.

The econometric model suggests that while household size, family incomes, and broadband access at work are important predictors of broadband usage, broadband pricing is not. This result is completely consistent with the body of existing literature on residential demand for broadband. The combined research suggests that residential consumers of broadband are quite insensitive to price. In fact, the price elasticity of residential demand for broadband access appears to be rapidly approaching zero given currently observed prices.

Overall, the survey results indicate a tremendous lack of information. Of the sample group as a whole, 51 percent were unable to say whether or not broadband is available to their household. Of those households that subscribe to traditional dial-up services, very few could provide information regarding the pricing of any available broadband alternative. Together, these results suggest that, in aggregate, there is not a significant amount of unmet residential demand.<sup>3</sup>

### *Study Conclusions and Policy Implications*

The analysis of the relationship between broadband availability and productivity suggests that many commercial subscribers are currently realizing productivity gains because of their broadband access. As a consequence, the economic benefits attributable to further network extensions are modest compared to the gains that have already been achieved. Similarly, the gains attributable to the network extensions necessary to reach additional residential customers appear to be modest based on the household survey results. In summary, to date, state-wide

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<sup>3</sup> The study team is certainly aware that there are any number of communities with residential users who do not share our conclusion.

policies have been effective in securing the benefits of broadband for most West Virginians for whom any benefits are possible.

This conclusion is not, however, an invitation to complacency. New broadband technologies and applications are appearing almost daily. What constitutes adequate broadband availability today may be simply unacceptable within a handful of years. Today, state policies and state and federal regulatory regimes appear adequate, and available benefits have been largely realized without sweeping governmental intervention. However, vigilance is paramount in a setting wherein currently undreamed of technologies may be commercially available in less than a generation. The emerging relationship between broadband and health care delivery alone is probably sufficient to warrant continuous monitoring and ongoing policy discussions. Policy-makers must remain informed and be prepared to change course very quickly should conditions warrant such actions.

Finally, the analyses included within the current study were intended to measure potential state-wide benefits attributable to network extensions, given currently available technologies. It is very likely that a disaggregation would quickly reveal individual communities or areas that both desire and need help in attaining broadband services. An important inquiry would be to determine why broadband is not available in areas where there is demand for it. It is our observation that state-level leaders can (and do) play an important role in identifying and brokering solutions for these communities. State-level personnel are capable of developing a level of expertise that simply cannot be replicated in every community. Therefore, from an economic vantage, this form of state intervention is an important remedy for what would otherwise be problems of asymmetric information. Intervention could also take the form of education in communities that have not yet received the full benefits of broadband in terms of business productivity and/or residential utility.

# Table of Contents

<u>Section</u>	<u>Page</u>
Executive Summary .....	3
1. Introduction and Motivation .....	8
2. Economic Benefits to Rural Users .....	11
3. Rural Households and the Demand for Broadband .....	14
4. Broadband and the Productivity of Rural Businesses .....	20
5. Summary and Conclusions .....	33
6. Postscript .....	37
7. Bibliography.....	39

APPENDIX A – The Data

APPENDIX B – Technical Appendix: Household Modeling

APPENDIX C – Technical Appendix: Productivity of Rural Businesses

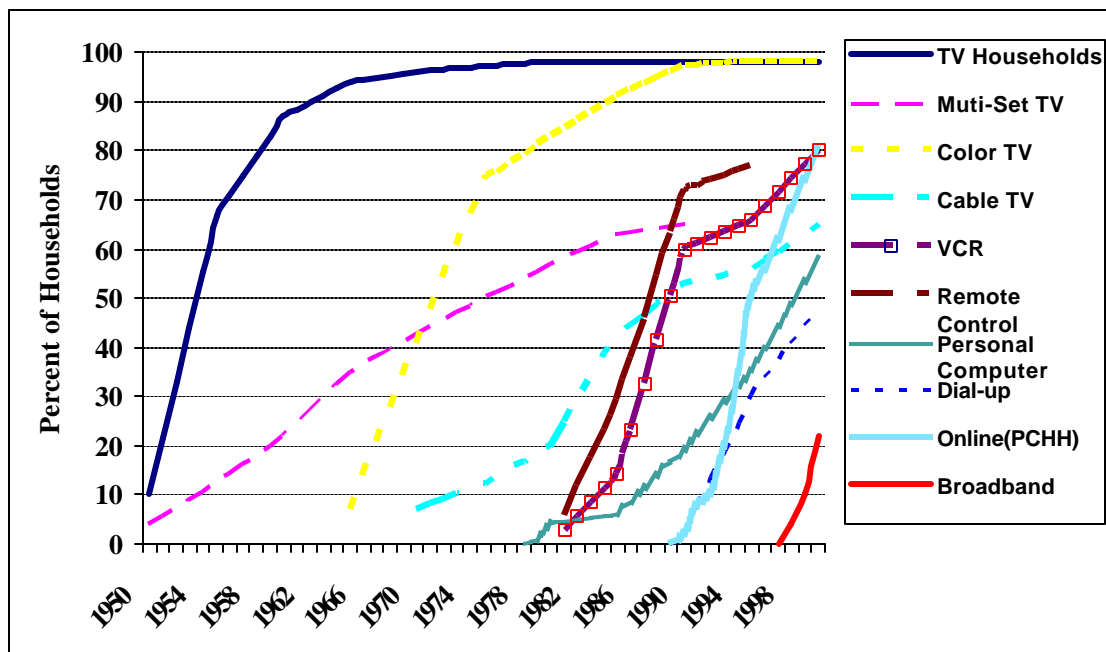
## **Figures and Tables**

Figure 1, Selected Technology Adoption Curves.....	4
Figure 2, Regional Broadband Access.....	5
Figure 3, Residential Access Elasticities Over Time.....	15
Figure 4, West Virginia Firm Locations Along Corridor G.....	17
Table 1, Characteristics of Internet Users.....	12
Table 2, Dial-Up or Broad for Internet Broadband Access.....	13
Table 3, Estimated Firm Productivity.....	18
Table 4, Multi-State Wage Model Results.....	22
Table 5, State-Specific Service Sector Wage Model Results.....	23
Table 6, State-Specific Finance Sector Wage Model Results.....	25
Table 7, Firm Locations in West Virginia.....	27

## 1. Introduction and Motivation

Loosely defined broadband is a set of telecommunications technologies used to transmit large volumes of digital information at high speeds. These technologies are valuable within the context of traditional data transmission applications and within a rapidly growing array of new commercial and residential applications. Perhaps because of the diversity of possible uses, broadband, as a whole, is being adopted more rapidly than nearly any other technological innovation, as the technology adoption curves provided in Figure 1 suggest.

Figure 1, Selected Technology Adoption Curves



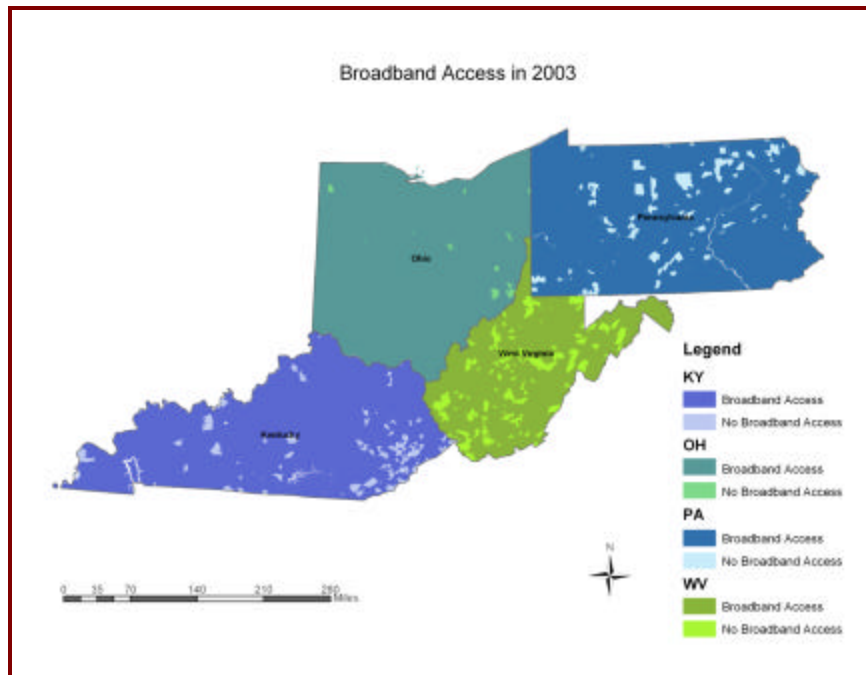
Source: Lilien, Rangaswamy and Van den Bulte [1999]; Owen, 2002; FCC

Given the rapidity with which broadband technologies have been embraced, it is not surprising that the emergence of these technologies has spawned a number of policy issues. These issues are made more complex by the diversity of broadband technologies. The two most widespread forms of broadband are (1) digital subscriber lines (DSL) supplied by local exchange telecommunications carriers and (2) two-way digital communications supplied by cable television providers over coaxial cable networks. Local exchange carriers also provide dedicated

broadband lines to higher capacity users and there are rapidly emerging wireless technologies through which remote digital users can be connected to traditional Internet facilities.<sup>4</sup>

In most large urban markets, each competing technology is available to both business and residential customers, sometimes from a variety of competing sellers. Most other metropolitan populations have access to, at least, one of the available broadband technologies. However, in the very rural areas, where population densities are notably low, broadband access is often nonexistent. This is, in fact, the case for a measurable portion of West Virginia's population.<sup>5</sup> Broadband access within the region is depicted graphically in Figure 2.

**Figure 2, Regional Broadband Access**



<sup>4</sup> Throughout this report we employ the Federal Communications Commission definition of Broadband, both technologically and regionally. The FCC reports a zip code as possessing residential broadband service if at least one household receives service with at least 200Kbps of asymmetric data transmission. We are excruciatingly aware of the criticisms of these definitions. For example, mailing a small packet of CD's will meet this definition (Odlyzko, 2003). We are also quite certain that no better definition has emerged. As will be apparent in our recommendations, effective changes to the utility provided by broadband may play a role in future policy developments.

<sup>5</sup> As of December 2004, the Federal Communications Commission estimates that seventeen percent of West Virginia zip codes have no broadband access. Moreover, services are often confined to small geographic areas in zip codes where broadband is available. In all, as of December 2004, 6.7% of West Virginia's residents lived in zip codes not served by broadband telecommunications. (Federal Communications Commission. *High-Speed Services for Internet Access: Status as of June 30, 2004*).

Within the public policy arena, advocates of public intervention in the provision of broadband services appear to be prompted by two separate, but not mutually exclusive, motivations. These include: (1) a desire to intensify the level of competition for broadband subscribers in areas where services are currently offered by a limited number of providers; and (2) a desire to see some form of broadband services made available to potential rural users who currently have no broadband access. It is this latter concern which motivates the current analysis.

Within West Virginia, broadband advocates have proposed an array of policies for extending access into rural communities where it is currently unavailable. The suggested set of policy alternatives includes (but is probably not limited to): (1) state investment in telecommunications infrastructure; (2) the creation of some form of universal service fund to subsidize either the public or private extension of broadband networks; (3) municipal provision of broadband infrastructures through public-private partnerships; and (4) compelling incumbent broadband providers to extend existing networks more rapidly through the use of existing regulatory procedures.

Evaluating these (sometimes) competing policy alternatives is far beyond the scope of the current analysis. Instead, the current study effort focuses on one lone task. We seek to evaluate the scope and magnitude of the benefits rural users can anticipate if broadband telecommunications reaches their communities. By providing these estimates, we hope to better inform subsequent discussions of specific telecommunication policy alternatives.

## 2. *Economic Benefits to Rural Users*

There are three specific sources of potential economic benefits in the event that broadband services are extended to rural communities where they are currently unavailable. These include: (1) Increased utility to rural residential users; (2) external network benefits that would accrue network-wide; and (3) increased productivity for rural business users. Each of these benefit areas is discussed theoretically within the current section. Actual benefit estimates are provided in Sections 4 and 5.

**Utility for Residential Users** Virtually every household in West Virginia has Internet access through traditional wireline telephony.<sup>6</sup> Nevertheless, tens of thousands of households within the state opt to pay a monthly premium in order to obtain faster access via broadband. FCC statistics on broadband usage combine residential and small business usage.<sup>7</sup> However, assuming 146 thousand purely residential users and a monthly premium of \$20, the total annual incremental payments for broadband access is \$35 million. Clearly broadband provides additional utility to residential users. Residential applications requiring broadband capacity include on-line gaming, music and video downloads, and voice over internet protocol (VoIP).

**Network Externalities** Very often, in a network setting, the utility of the network to existing users increases as additional new users choose to participate in the same network. For example, in traditional wireline telephony the value of the network to existing users is largely a function of how many other people they can contact by phone. Adding a new household to the network provides existing households and businesses with a new opportunity to communicate with additional residents. Thus, there are benefits to the existing users attributable to the new household's decision to purchase phone service. Because existing users are neither paying for the new household's service nor participating in the decision process, the benefits to the current

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<sup>6</sup> In 2001, the FCC reports that 94.5% of West Virginia roughly 756,000 households have home telephony. (Federal Communications Commission, Telephone Subscribership in the United States, 2002).

<sup>7</sup>This combined total of residential and small business DSL and cable broadband subscribers for West Virginia was 151,163 as of December 2004. Federal Communications Commission. *High-Speed Services for Internet Access: Status as of December 31, 2004*

users are referred to as “external” benefits that are attributable to the network production process or simply positive “network externalities.”

In the case of positive externalities (as in the illustration above), economics suggests that unfettered markets will under-produce the good or service in question. Accordingly, the appropriate policy response is for the government to intervene in a way that will increase the amount of the good or service that is purchased in each time period. For example, in the case of traditional telephone service, the government has elected to subsidize service for new users through a Universal Service Fund paid for by existing users.<sup>8</sup>

Within the current context, the question is whether or not existing residential telecommunications users are made better off when a new user elects to purchase broadband services. For existing wireline users, the answer is almost certainly “no”. For existing broadband users, the answer is less clear. Those residential users who use broadband access for entertainment purposes may, in fact, benefit as broadband usage increases. Gamers gain new opponents and those users who trade music and/or video images may enjoy increased choices as broadband network usage grows. Further, the much discussed but hitherto unobserved “killer apps” (high-end broadband applications) that may yield dramatic increases in utility may be unprofitable (and, therefore, absent) until a much higher proportion of households subscribe to broadband. Thus, growth in user utility is likely to correspond positively with increasing total network reach. Ultimately, it is probably imprudent to fully and permanently dismiss the matter of network externalities. Unfortunately there is currently no means of estimating the magnitudes of any existing effects, so that the current analysis must rest with the qualitative discussion provided above.

**Increased Firm Productivity** Broadband telecommunications services represent a potential input into the productive processes through which firms produce goods and services. For some firms, the availability of broadband will offer little or no advantage. For other firms, broadband

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<sup>8</sup> The majority (53 percent) of Universal Service Fund payments go directly to carriers through the High Cost Support Program. It should be noted that the positive externalities used to justify this fund were never quantified, thus creating the strong potential to overprice this payment. Other universal service mechanisms include subsidies targeted at low income subscribers, subsidized service for schools and libraries, and subsidies for rural health care providers.

communications may yield sizable increases in productivity and corresponding increases in the quantity of firm outputs. The importance of broadband access depends on a variety of factors. These include (1) the price the firm receives for its outputs; (2) the price of broadband service; (3) the prices of other necessary inputs; and (4) the extent to which broadband may complement or be a substitute for other productive inputs.

Broadband provides communications capacity that translates into speed and the ability to transmit previously impractical data volumes. Both facets can be important within the production process. Consider for example financial institutions. Well before the widespread availability of DSL or cable broadband, financial services providers routinely subscribed to dedicated lines in order to accommodate both data volumes and the service requirements of their customers. With the growing availability of less expensive broadband services, firms in other industries are now able to perform similar tasks, albeit with differing aims and without dedicated lines.

Readers should, however, take care not to confuse the productive influence of the Internet with the efficiency potentials offered by *high speed* Internet access. The emergence of Internet (digital) communications, in and of itself, radically changed production processes for a wide array of users. Moreover, for at least some of these users, the higher speeds afforded by broadband will not necessarily yield productive increase beyond what has been attained through narrow band Internet access. It is also important to consider where within the production (or distribution) process communications speed is necessary. For example, a firm that hosts client web-sites may desire broadband so that it can communicate more effectively with client customers. The clients themselves may not require high speed service to retrieve orders or other customer information.

### ***3. Rural Households and the Demand for Broadband***

Nationally, there has been a strong growth in the demand for residential broadband service. Statistics suggest that approximately 51 percent of residential users in the U.S. access the Internet via a broadband connection. High speed usage has also increased in West Virginia. The total number of lines increased from just over six thousand in December of 2000 to more than 155 thousand in December of 2004 and of these lines, the vast majority (151 thousand) are used by either residential or small business customers.<sup>9</sup>

Regional access to broadband communications has been explored by a number of analysts.<sup>10</sup> In order to add to this existing research and develop results that are specific to West Virginia, we first analyzed data on broadband availability and demographic and economic data describing the residents of more than 4,300 zip codes in Kentucky, Ohio, Pennsylvania and West Virginia. Though a number of factors are statistically related to the presence of broadband, only educational attainment and the relative size of age groups provide any statistically meaningful explanation of the presence of broadband. Combining 2003 broadband data with the largely static data from the 2000 census we found an increase in a region's proportion of 5-24 year olds by one percent increases a region's probability of having access to broadband communications by 50 percent, while reducing the proportion of adults without a high school diploma by one percent increases the probability of a zip code having broadband by almost 65 percent. In contrast, an increase in median household income of roughly \$1,000 per year only increases the probability the zip code will have broadband access by 0.4 percent, and a reduction in median house age of 100 years, will increase the probability of broadband access by less than 1 percent. Most surprisingly, population density played a small role in broadband availability. Adding 1,000 persons per square mile in the sample area was associated with an increased probability of broadband access of less than 4 percent.<sup>11</sup>

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<sup>9</sup> Federal Communications Commission. *High-Speed Services for Internet Access: Status as of June 30, 2004*.

<sup>10</sup> See, for example, Grubestic (2003) or Grubestic and Murray, (2004).

<sup>11</sup> We employed a multinomial probit for each of the years of broadband regressed on 2000 Census. The goodness of fit measure (McFadden's R-squared) dropped by half over the five years tested, strongly suggesting the link between regional characteristics and broadband availability is weakening.

Our results very clearly suggest that demand conditions have played a critical role in determining whether or not a region enjoys access to broadband. This having been said, the demographic and economic characteristics of would-be purchasers are declining in their predictive power. This is almost certainly due to its rapid rollout in less affluent and more rural regions reducing the correlation between rurality, and its associated characteristics and access to broadband.

Turning our attention specifically to West Virginia, at least in the aggregate, there does not appear to be a substantial amount of unmet residual demand within the State.<sup>12</sup> As a part of the study process, CBER surveyed 600 West Virginia households.<sup>13</sup> A comprehensive summary of the survey results is provided here as Appendix B. There are, however, several points worth highlighting. First, of the 600 households, roughly half (299) connect to the Internet. This is notably less than the 66 percent penetration rate observed nationally.<sup>14</sup> This is likely a function of the state's demographic characteristics - an older and less educated population with below-average rates of computer ownership - rather than a function of access to the Internet.<sup>15</sup> For those West Virginians who do use the Internet at home, the split between traditional dial-up usage and broadband is also lower than the national average (42 percent state-wide versus 51 percent nationally). On the whole, residential broadband users appear to more educated and more affluent than their dial-up counterparts. A modest set of demographic and economic statistics is included within Table 1.

Presumably, if there is substantial unmet demand for broadband services it would rest among dial-up users who would prefer to purchase broadband services. However, of the 173 dial-up users surveyed, 37 percent did not know whether or not they currently have access to

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<sup>12</sup> There are certainly individual households that would very much welcome the extension of broadband networks in to areas where service is currently unavailable.

<sup>13</sup> This survey was a random sample of 600 West Virginia households. It is possible that the willingness of those surveyed to participate could have influenced the results by picking up individuals who were already more interested in this topic.

<sup>14</sup> Federal Communications Commission. *High-Speed Services for Internet Access: Status as of June 30, 2004*.

<sup>15</sup> Our analysis of more than 4,300 zip codes in Kentucky, Ohio, Pennsylvania and West Virginia found that age distribution and educational attainment were the two dominant factors in broadband access, with either effect rendering income virtually irrelevant.

broadband service (cable, DSL, or wireless).<sup>16</sup> Moreover, of the group of dial-up users who could confirm that they have access to some form of broadband service, only 32 percent had any knowledge of the prices for available services. Finally, only six of the 173 current dial-up customers indicated that they are willing to pay more for broadband than they currently pay their dial-up Internet service provider and for those six, the additional monthly premium they were willing to pay was less than \$10.

**Table 1 – Characteristics of Internet Users**

	<i>Dial-Up Users</i>	<i>Broadband Users</i>
Median Household Income	29,794	33,049
Median Per-Capita Income	16,180	18,157
Median Age	39	39
% of Population did not finish High School or Equivalent	24.5%	21.2%
% of Population with High School or Equivalent	39.5%	37.0%
% of Population with Some Higher Education	21.1%	23.3%
% of Population with a Bachelors Degree	9.0%	11.1%
% of Population with a Graduate Degree	5.9%	7.4%

**Source: US 2000 Census. All values are for the zip code of residence.**

Given that a substantial portion of dial-up users could not say whether or not they have access to broadband services, and of those who could there was little awareness of price, it is challenging to statistically model the relationship between availability, pricing, and subscribership as has been done elsewhere.<sup>17</sup> While a substantial number of West Virginia households have embraced broadband, those who have not appear to be relatively disinterested in the topic. This is not, however, an outcome that is likely to persist indefinitely.

<sup>16</sup> Across the entire survey 51.5 percent of respondents did not know whether or not they have access to broadband services.

<sup>17</sup> There have been numerous attempts to model residential demand for broadband services. Perhaps, one of the most comprehensive efforts is that of Rappoport, Kridel, Taylor and Alleman (2004).

Modeling demand relationships is difficult when a large number of consumers are unaware of available prices. However, we were able to glean information regarding the relationship between broadband access and several other factors.<sup>18</sup> To do so, we first modeled the choice to access the Internet (either through dial-up or broadband), finding results very similar to earlier studies of Internet usage. We also modeled the choice of dial-up or broadband among those who access the Internet.<sup>19</sup> The results of the second stage process are reported in Table 2.

**Table 2, Dial-up or Broad for Internet Broadband Access  
(Ordered Logit Estimates)**

<b>Variable</b>	<b>Coefficient</b>
Have Broadband at Work	-0.242714**
Number of Adults in Family	0.781561***
Number of Kids in Family	0.595455***
Age of Youngest Family Member	-0.012353
Percent Population > 25 with BA degree	-4.766761
Median Age	-0.045488
Median HH income	0.0000835***
Broadband Price (actual, but not necessarily known)	0.004993
c1	1.209799
c2	2.214068
Pseudo R2	0.11
Likelihood Ratio Statistic (8 d.f.)	65.19842***
Akaike Information Criterion	1.94107

\*\*\* statistically significant to the 0.01 level, \*\* statistically significant to the 0.05 level, \* statistically significant to the 0.10 level, † statistically significant to the .20 level.

<sup>18</sup> Our survey revealed that a trivial proportion of dial-up users and virtually no residents without Internet access knew the prices of broadband. Thus, our ideal strategy of estimating a nested logit model (where broadband vs. dialup was a second, or nested choice following the decision to access the Internet at home) was complicated by the absence of pricing knowledge. We are forced to make one of two assumptions. We could choose the unappealing option to ignore price as a decision variable for Internet access in our statistical model or use the actual price for each zip code, assuming that this price matters in the decision even though respondents did not know what the price may be. This is not a new problem, and was highlighted earlier this year by Chaudhuri and Flynn [2005]. Also, the leading analysis of this problem (Rappoport, Kridel, Taylor and Alleman [2004]) mixed both survey and regional pricing data (much as we have done) to estimate access elasticities. We consider this a question best resolved in later research. Insofar as access elasticity matters, neither approach yields different results in these data. Access elasticity is not different from zero.

<sup>19</sup> An early and errant model specification included a dichotomous variable indicating whether or not the residence is in a zip code where broadband is available, as well as the variable denoting whether or not the respondent knew if broadband is available. Not surprisingly, both variables were highly significant. Consequently, the authors can say with virtual certainty that very few households accidentally subscribe to broadband services in areas where they are unavailable.

As expected, the price of broadband service is not a statistically significant predictor of the decision to subscribe to broadband service. Somewhat surprisingly, however, both the measure of household education and the age of residents also failed to attain statistical significance at a ninety percent level of confidence. The results do suggest that, for the sample group, higher incomes are positively correlated with the probability that the household selects broadband instead of wireline service. Also, it appears that at least some households are willing to substitute broadband service at work or school in place of home access.

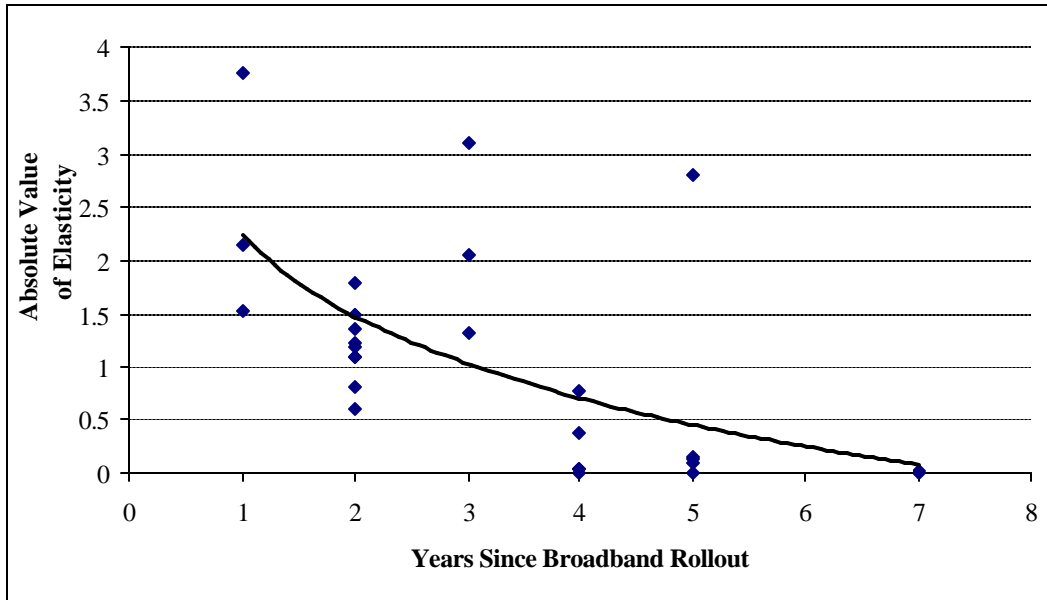
Perhaps two of the most interesting results involve the coefficient estimates for the variables denoting the number adults and the number of children residing within the household. Both coefficients are positive and highly significant. We believe this is likely a reflection of the opportunity cost of slow Internet access in relatively busy households. Moreover, if the result was driven by the demands of the children, we would have expected the children's age variable to be significant, but it is not. Instead, it appears to be the opportunity costs to the adults that drives this relationship.<sup>20</sup> This finding is certainly consistent with Rappaport, Kridel and Taylor (2002) who also find the opportunity cost of time to be positively correlated with broadband subscription rates.

The West Virginia survey results strongly suggest that, given the currently observable set of prices, broadband pricing plays little or no role in residential consumption decisions. Thus, the current price elasticity of demand appears to be very nearly zero. This outcome is completely consistent with residential behaviors observed in other parts of the nation. Figure 2 depicts various estimates of residential demand elasticities plotted over time. Collectively, these estimates tell a compelling story. Even without any appreciable change in real prices, residential elasticities appear to be trending toward zero. This is a clear extension of the observed trend across all the existing studies of access elasticity over the past decade.

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<sup>20</sup> We have no direct evidence from the survey questionnaire that opportunity costs of time are higher in households with children. However, we shall only entertain criticism of this interpretation from readers with children.

**Figure 3, Residential Access Elasticities Over Time**



As broadband services are extended and the number of applications (and other users) has increased, residential broadband access is increasingly being viewed as essential by an ever increasing number of households. There is no *a priori* reason to expect that this would not be the case in West Virginia as potential users become familiar with available applications and obtain the skills necessary to execute those applications. Once again, however, we must offer the caveat that this result applies only for the currently observable set of broadband prices.

#### ***4. Broadband and the Productivity of Rural Businesses***

As described in Section 2, the availability of broadband telecommunications services has the potential to improve the productivity of commercial users. The ultimate impact of improved telecommunications services depends on the nature of firm-specific production functions, as well as the price of other productive inputs and the prices of the products or services that the firm sells. Nationally, there is evidence that extending broadband service to commercial users has contributed to firm efficiency, particularly among smaller producers.<sup>21</sup> This having been said, the current study team and the Steering Committee which guided it felt it necessary to explore commercial impacts specific to West Virginia. The study team found these impacts to be significant for the Finance and Services sectors, but not for the economy as a whole.

To the extent that broadband contributes to efficiency, we should observe a number of identifiable impacts. Firms with broadband access should be more productive in terms of the amount of output they are able to produce with fixed quantities of other inputs. In turn, productivity improvements attributable to broadband should allow firms to better reward the other productive inputs. This means (potentially, at least) higher returns to capital inputs – hence greater investment — and higher wages for workers. Finally, if broadband genuinely adds a competitive advantage, competition should lead to an outcome in which areas without broadband service will fail to sustain or attract firms in industries where these services are important.

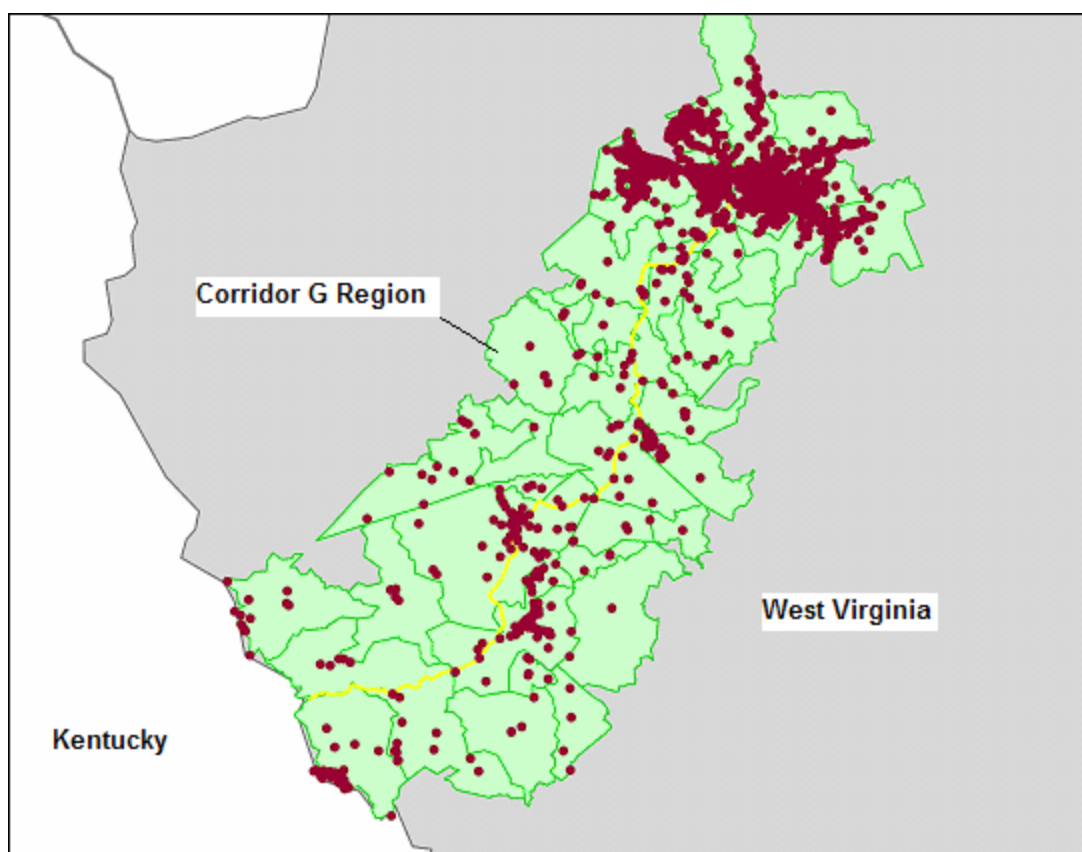
To actually quantify these potential impacts, the study team undertook three empirical activities. First, we modeled the relationship between output per worker and access to broadband services as a means of identifying productivity impacts. Second, we attempted to correlate wage differentials to broadband access across industrial sectors. Finally, we examined firm locations in relationship to broadband availability. The results of each activity are summarized within the remainder of the current section.

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<sup>21</sup> Not only does the evidence suggest that broadband access is important to small firms, there is also empirical evidence that this access is particularly important to firms that operate from multiple locations. BJK Associates “Broadband for Rural Small Businesses” 2001.

**An Empirical Evaluation of Broadband and Firm Productivity** Within this initial process, we directly estimated the role of broadband availability at the firm level through the use of data developed in an earlier study on firm productivity and highway infrastructure. This allowed us to test the role of broadband on the productivity of almost 8,000 firms located in West Virginia and Kentucky along US 119 (Appalachian Development Highway System Corridor G).<sup>22</sup> Firm locations are depicted in Figure 4.

**Figure 4, West Virginia Firm Locations Along Corridor G**



The data describe individual establishments located in zip codes that are within 15 miles of US 119. The region begins with zip codes contiguous to the West Virginia capitol building, passes through some of the most rural parts of West Virginia into Kentucky, terminating in Pikeville, KY. For each firm, (in year 2000) the data detail employment, revenues, firm legal

<sup>22</sup> Hicks, Michael J. The Impact of Appalachian Corridors on Small Business, *Transportation Research Board National Academy of Sciences, Proceedings, Transportation and Economic Development 2001*.

structure, size, 4-digit SIC Code, number of reported SICs and the suite of census data. We measure productivity as the revenues per worker within the firm. Of particular interest is actual proximity measured by road distance to US 119, the infrastructure measurement in the earlier study.

The earlier research identified a modest role for highway infrastructure as a means of explaining firm productivity. We have added the availability of residential broadband to that specification.<sup>23</sup> To evaluate the relationship between firm productivity and broadband we estimated the relationship between revenue per worker and firm and regional characteristics (including broadband access). A more detailed explanation of this model appears in the Technical Appendix. However, Table 3 summarizes estimation results.

**Table 3. Estimated Firm Productivity**

<i>Variable</i>	<i>Logit</i> <sup>24</sup>	<i>OLS</i>
C	8.475339***	9.150856***
Distance to Corridor G (feet)	-0.250432†	-0.147382
Distance to Corridor G squared	0.013835†	0.007741
Broadband*Age of Firm	-0.174906*	-0.147507*
Broadband	0.11164	0.077964
Age of Firm	0.510805**	0.372638*
Age of Firm Squared	0.059398	0.088066**
Urban Zip	0.0444	0.296379**
Population	0.042774†	0.085633***
Number of Households	-0.043865	-0.307219**
Number of SIC Codes	0.709776***	0.242038*
Privately Owned	-0.023441	-0.076569**
West Virginia	-0.099375*	-0.059841
Per Capita Income	0.647904***	0.418935***
Adjusted R-squared	0.046	0.46
S.E. of regression	0.561837	0.561735
Log likelihood	-2325.072	-2325.072

\*\*\* statistically significant to the 0.01 level, \*\* statistically significant to the 0.05 level, \* statistically significant to the 0.10 level, † statistically significant to the .20 level.

<sup>23</sup> The data describing broadband availability reflect the presence or lack of DSL, cable modem service or wireless broadband access anywhere within a specific zip code. While it is unlikely that this variable is perfectly correlated with the availability of broadband services to commercial customers, it remains the best measure available.

<sup>24</sup> These techniques are extreme value Logit and ordinary least squares. The two techniques are employed due to different statistical assumptions, which we discuss in the appendices.

Both models yield similar results. In particular, proximity to the Appalachian Development Corridor matters, with an additional mile increasing productivity by roughly one quarter of a percent, with this an increasing function.<sup>25</sup> Older firms in urban areas that produce goods or services in more than one Standard Industrial classification, and those that are located in more affluent areas, are more productive. Publicly traded firms in the sole Kentucky county we examined had higher levels of productivity (possibly due to a high percentage of the zip codes being urban).

The Table 3 results suggest that the availability of broadband, by itself, is not statistically significant as an explanation of firm productivity. This outcome may be attributed to a combination of three possible causes. First, the dissemination of broadband, as well as any productivity-related impacts was limited in 2000, the year from which the data were drawn. Second, as will be further discussed, the spatial distribution of firms within the Corridor G setting makes it impossible to disaggregate the data to the industry levels that would have, perhaps, yielded more revealing results.<sup>26</sup> Finally, the data do not reflect those instances in which firms secured dedicated broadband access from Verizon, the dominant local exchange carrier within the region and thus are likely to underestimate the number of firms who had access to broadband.

These results do provide one extraordinarily important finding. While broadband access by itself was not a contributor to firm productivity, its interaction with the age of the firm was an important explanation for differences in firm productivity. This result points to an important, and often overlooked characteristic of firm location dynamics and broadband: simply, most firms made their location choices prior to the development of broadband. The mean age of the firms in

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<sup>25</sup> However, this finding was sensitive to specification (Logit only) and was not statistically different from zero at the ten percent level. This finding suggests that earlier research performed on the Appalachian Development Corridor which did not include accounting for broadband access may need to be re-evaluated in light of this finding. See Hicks, Michael J. The Impact of Appalachian Corridors on Small Business, *Transportation Research Board National Academy of Sciences, Proceedings, Transportation and Economic Development 2001*.

<sup>26</sup> We performed some limited disaggregation, however the data supported little of this. We did find the service sector most affected by broadband presence. No financial services firms located in zip codes without residential access. We discuss this implication in our later analyses.

this sample is 18.2 years, so that most firms made chose a location more than a decade before telecommunications became available. We find in this sample of firms that age and broadband access interact to explain a significant proportion of productivity differences across firms. Specifically, for each firm located in a broadband accessible zip code, productivity increases by between 14 and 17 percent over a similarly aged firm locating outside a region with broadband access. Younger firms are locating where broadband is available and are generally more productive.

This is a nontrivial impact for an individual firm, and certainly would likely matter in firm location decision. Indeed, this finding provides the most direct available estimate of firm level productivity due to access to broadband that we have encountered in the literature. However, the aggregate impact is small, even for data that is quite stale in terms of broadband access. In 2000, along a relatively remote and poor area of West Virginia the incremental benefit in terms of production associated with extending broadband to firms who did not have access to residential service would have been under one million dollars annually.

In order to better understand the age/broadband interaction we also tested to determine whether or not the average productivity of firms that located without regard to broadband, and that of those that were broadband sensitive in our sample were statistically different. While firms that located only in areas with residential broadband enjoyed a roughly 3 percent higher productivity, the difference was not statistically significant. However, the differences in the other distributional characteristics of the productivity values were quite telling.

While the average productivity of firms located within and outside broadband accessible areas was not different, there was a very clear presence of more very highly productive firms which were located within broadband accessible regions. This suggests a tendency for very productive firms to locate in places with broadband. Further, among the firms that located in places without broadband, there was more clustering around the mean, with far fewer modestly higher productivity firms. In the view of the study team, these differences stand as tentative evidence of the effects that broadband access may have on firm location decision and productivity now, or within the foreseeable future. However, analysis which evaluates the role

broadband has played dynamically in regional growth may lead to better insights into the both the history and potential future roles of access to broadband on aggregate economic activity.

**Broadband access and Worker Wages** While the initial investigation of productivity found important, if modest productivity impacts directly attributable to broadband access, it is further possible to both identify and quantify any such impacts through their secondary impact on wages. Specifically, firms that are more productive are be able to pay workers higher wages. Moreover, if markets for labor are effectively competitive, wage premiums to more productive labor will not be voluntary. Thus, if broadband contributes to firm productivity, we should observe higher wages in those areas where broadband services are available. In order to explore this potential relationship, we used the population distribution from the 2000 Census to allocate population within the county. The reported annual changes in population are distributed evenly across the county each year. This forms the core of the data used to evaluate the aggregate and sectoral wage impacts of broadband access from 1995 through 2003.<sup>27</sup> This model was estimated for selected two-digit SIC sectors individually for the states of West Virginia, Kentucky, Ohio, and Pennsylvania and collectively within a multi-state specification. The model accounts for past levels of wages, regional impacts, the most recent recession, the technology sector decline and the availability of broadband telecommunications.<sup>28</sup>

Because of their product offerings and service production processes, we were particularly interested in the potential impact of broadband on the wages within the Services and Finance sectors. This interest was further bolstered by two important studies on the role of information technology at the industry level. Stiroh (2001) examined the role of information technology on individual industries at the two digit level, finding the impact of IT on services dominating much of the aggregate impact. Interestingly, Stiroh did not examine either finance or IT producing sectors as the very obvious consumption and production of IT in these sectors unambiguously suggested he would find an impact. A second study of IT relating to productivity growth in the UK found that finances and services explained virtually all the aggregate impact of IT (Correa,

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<sup>27</sup> Clearly broadband was unavailable prior to 1998, but this time period permitted us to include a greater number of lagged dependent variables in our model, as might be appropriate. Also 2003 is the most current data available.

<sup>28</sup> We estimated county level broadband access as a percentage of residents in that county living in a zip code with broadband access each year.

2003). Thus, if we are to find impacts of broadband it would behoove us to examine those sectors already identified as having exhibited productivity gains due to IT. Productivity gains to IT within and industry should serve as a necessary, but not sufficient condition to the presence of productivity benefits attributable to a more limited IT component – broadband. As a test of this assumption we also tested the total wages as a comparison of the models, in all cases the real wage values are in logarithmic form for ease of interpretation. Results for the cross-state aggregation are provided in Table 4.

**Table 4. Multi-State Wage Model Results**

<i>Variable</i>	<i>All Jobs Coefficient</i>	<i>Finance Coefficient</i>	<i>Services Coefficient</i>
<i>(intercept)</i>	8.828665***	0.083758	-2.728118
<i>(broadband)</i>	0.000788	-0.030047	-0.044281
<i>t-1 (broadband)</i>	0.002651	-0.005857	-0.008073
<i>(spatial autocorrelation)</i>	5.96E-05***	1.001739	1.813129***
<i>t-1 (spatial autocorrelation)</i>	-8.72E-06**	-0.075115†	-0.006296
<i>X1 (recession)</i>	-0.012982**	0.002515	-0.066457**
<i>X2 (2001 dummy)</i>	0.005634*	0.008551	0.007212
<i>(autocorrelation)</i>	0.551523***	0.450772***	0.542878***
Adjusted R-squared	0.97	0.87	0.82
S.E. of regression	0.027961	0.107073	0.106839
Durbin-Watson stat	1.99	1.86	2.12

\*\*\* statistically significant to the 0.01 level, \*\* statistically significant to the 0.05 level, \* statistically significant to the 0.10 level, † statistically significant to the .20 level.

The results of these regressions suggest that in a geographically aggregated setting, broadband access does not explain any observable wage differentials. This is true for the cross-industry specification, as well as those estimations specific to the Financial and Services sectors. The dominant factors were the spatial or regional influence and wages in the previous period. This is a consistent finding in almost all spatial models of economic growth. The 2001 recession also led to wage reductions in aggregate and on the Services sector, but did not affect wages in the Financial sector with any statistical significance. The magnitude of the recession impacts was extremely modest, with impacts of between 0.02 and 6.6 percent for all wages and in Services. This is consistent with most other estimates we have seen (albeit with modestly higher

impact in services). We also attempted to identify broadband impacts that are specific to rural communities, defined here, as counties lying outside Metropolitan Statistical Areas (MSAs). Again, however, there was no impact attributable to broadband access on aggregate wages or wages in the Services or Finance sectors for the multi-state specification.

We anticipated state-level differences in the commercial impacts of broadband availability. Accordingly, the next step was to test our model on aggregate and sectoral wages in Services and Finance on a state-by-state basis. As with the multi-state study area and the non-MSA counties, aggregate wages within individual states were not affected by broadband access. However there were state level impacts of broadband access for Services and the Financial sectors in Ohio, Pennsylvania and West Virginia, but not in Kentucky. The results for the Services sector appear in Table 5.

**Table 5. State-Specific Service Sector Wage Model Results**

	KY	OH	PA	WV
<i>(intercept)</i>	-0.78876	0.985071	1.637126***	2.78389*
<i>(broadband)</i>	0.023672	0.056003†	0.049734***	0.073141*
<i>t-1(broadband)</i>	-0.01931***	-0.02725*	-0.00592	-0.01336
<i>(spatial autocorrelation)</i>	1.218585	1.077958***	0.354074**	0.280402
<i>t-1(spatial autocorrelation)</i>	-0.02126	-0.43343**	0.09451	-0.22494*
<i>X1 (recession)</i>	-0.04118*	-0.02784†	-0.02631***	-0.02236
<i>X2 (2001 dummy)</i>	-0.01386	-0.01689†	0.011614	0.019167
<i>(autocorrelation)</i>	0.513412***	0.425024***	0.887119***	0.463508***
Adjusted R-squared	0.767133	0.889928	0.941056	0.911554
S.E. of regression	0.116849	0.072853	0.057312	0.077218
Durbin-Watson stat	2.21743	2.111413	1.834619	2.033289

\*\*\* statistically significant to the 0.01 level, \*\* statistically significant to the 0.05 level, \* statistically significant to the 0.10 level, † statistically significant to the .20 level.

In the Service sector in Pennsylvania and West Virginia there is support for the hypothesis that broadband access positively influences wages. In Pennsylvania, we observed an increase in wages of roughly 4.9 percent associated with the presence of ubiquitous broadband in a county. For West Virginia the associated impact was roughly 5.2 percent, with as much as a 5.6 percent increase in Ohio, though the level of statistical significance is weak. We found no

impacts in Kentucky.<sup>29</sup> The magnitudes of these findings warrant considerable attention, given the increasingly prominent role of the Service sector in new job creation.

These impacts translate into an estimated \$1,308 in increased service sector wages attributable to broadband. If historical relationships were applied throughout the state, in Pennsylvania the presence of broadband would raise individual Service sector wages by roughly \$110 million per year if broadband was brought to those zip codes where it currently does not exist. In West Virginia, broadband was observed, although less strongly, to be associated with a Service sector wage differential of roughly \$1,519 per worker. This translates into a statewide impact of broadband on service sector wages of more than \$314 million. The gains associated with extending broadband to all zip codes would account for a roughly \$32.6 million one time, non-transient increase in service sector earnings. As in Pennsylvania and West Virginia, Ohio's service sector workers located in broadband accessible regions earn roughly \$1,287 more per year. However, given the extensive broadband coverage in Ohio, extending broad to unserved areas would account for only about \$27 million in wage benefits to the service sector.

These impacts are important, and within the scale of other recent technologies quite large, however one major cautionary note is warranted. Given current technologies and production processes, the overwhelming majority of these impacts have already been realized since broadband access is widespread throughout Ohio, Pennsylvania and West Virginia. As aforementioned, as of 2003 only 6.7 percent of West Virginians lived in zip codes without any access to broadband. In Pennsylvania that figure was 1.4 percent, and only 0.6 percent of Ohio residents live in zip codes without broadband access. Again, given current technologies and applications, as yet unattained impacts are modest. In West Virginia, extending broadband access to areas where broadband is unavailable would add \$32.6 million to service sector incomes. Similarly, in Pennsylvania the statewide impact of ubiquitous broadband access on service sector wages would be roughly \$110 million, and an additional \$27 million for Ohio.

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<sup>29</sup> Closer examination of Kentucky reveal that the 2001 change to NAICS may have led to a 16% increase in the FIRE sector, most likely a redefinition of existing firms, primarily from services. This anomaly precludes better analysis.

We find a similar result in the impact of broadband on wages in the Financial sector. In West Virginia, workers in broadband-served areas enjoy an almost 11.2 percent wage differential. In Pennsylvania the difference is a little more than 4.4 percent. However, the coefficient estimate does not experience common levels of statistical significance (See Table 6). Workers in Pennsylvania's Finance, Insurance and Real Estate sector experienced a roughly \$1,348 earnings increase that is attributable to broadband. The additional income in this sector that would be attributable to ubiquitous broadband availability would be roughly \$25.6 million statewide.

The impact in West Virginia is proportionately much larger with an estimated 11.2 percent increase in Finance sector wages associated with broadband access. If historical relationships were applied throughout the state, this would translate into \$2,250 per worker or \$12.2 million in state-wide earnings that could be realized from an extension of broadband to areas not yet served. In Ohio the per worker impact is similar to that of West Virginia, but due to the widespread coverage of broadband access the total impact across the state is roughly \$15.5 million.

**Table 6. State-Specific Finance Sector Wage Model Results**

	KY	OH	PA	WV
<i>(intercept)</i>	2.770219	4.712759**	0.779468*	1.055483†
<i>(broadband)</i>	0.052901	0.118629*	0.04974†	0.112331**
<i>t-1(broadband)</i>	0.024332*	0.007191	-0.0395**	-0.01054
<i>(spatial autocorrelation)</i>	0.211818†	-0.42393	1.010244*	0.542992**
<i>t-1(spatial autocorrelation)</i>	-0.14596	-0.0988	-0.25727*	0.035854
<i>X1 (recession)</i>	-0.02137**	0.023879	0.014683	-0.02594
<i>X2 (2001 dummy)</i>	0.035887†	0.078294**	-0.02214	0.075596**
<i>(autocorrelation)</i>	0.366064***	0.437868***	0.529745***	0.328048***
Adjusted R-squared	0.828521	0.877696	0.935132	0.6867
S.E. of regression	0.101404	0.097225	0.095452	0.125138
Durbin-Watson stat	1.855819	1.90528	1.927908	1.84888

\*\*\* statistically significant to the 0.01 level, \*\* statistically significant to the 0.05 level, \* statistically significant to the 0.10 level, † statistically significant to the .20 level.

Our selection of the Service and Finance sectors for analysis in this section was motivated by our hypothesized transmission mechanism between broadband use and firm productivity. While we were unable to isolate this productivity impact in our first suite of estimates, we attributed this to the absence of some very specific industries within the service and FIRE sectors. This test of the more aggregate measures suggests that broadband access has played a non-trivial role in the productivity growth within these sectors. We were unable to isolate impacts in other sectors, or aggregate incomes in our study region. Thus it is likely that, at this time, the measurable productivity impacts of broadband access are limited to these two sectors.

Our findings in these estimations also speak broadly to problems of endogeneity, or the direction of causation between incomes and broadband access that naturally plague studies of this type. While we have attempted to ameliorate this problem in our estimates through the technical application of the statistical technique of two-stage least squares, the strongest evidence that endogeneity is not an issue within our findings are in the results themselves. Since we find that broadband impacts are confined to two economic sectors (as opposed to impacts that are economy-wide), it is not inconsistent with the data to assume that broadband access within these sectors that is driving wages rather than the reverse.

We note that these models portray both time and spatial autocorrelations and the recession as theory and other empirics suggest are correct. This provides us comfort in the quality of the model in explaining the role of broadband on wages in two sectors where the transmission of productivity impacts is well documented.

Finally, we note that the wage benefits associated with broadband deployment may represent enticing opportunities for welfare gain. We note that as of 2002 most of these benefits had already been achieved.

**Firm Locations** Ultimately, if access to broadband telecommunications confers a significant competitive advantage to resident firms, and assuming effective competition, producers who lack

this access will not survive. Accordingly, we expect to observe that certain economic activities are confined to areas where broadband is available and absent where it is not.

Table 7 provides data describing firm locations for a number of relatively disaggregated industries. These industries represent specific commercial activities that only take place where broadband services are available. Again, the empirical results described above suggest that the limitations imposed by a lack of broadband access have yet to become evident in aggregate regional or state-wide economic outcomes. Though, as we mentioned earlier, the productivity advantage explained by the interaction between age and Internet access should begin to matter to firms.

**Table 7. Firm Locations in West Virginia**

<i>Sample of Industries Absent in Zip Codes without Residential Broadband Access</i>
Cable & other pay television broadcasting
Communication services, n.e.c.
Electric services
Travel agencies
Process control instruments
Measuring & controlling devices, n.e.c.
Surgical appliances & supplies
Jewelry, precious metal
Silverware & plated ware
Dolls
Sporting & athletic goods, n.e.c.
Periodicals
Veterinary Services for Livestock
Automobile parking
Automobile parking
Motion picture production and allied services
Motion picture theaters
Legal services
Forestry Services
Coal mining services
Crude petroleum & natural gas
Oil & gas exploration services
Oil & gas field services, n.e.c.
Nonmetallic minerals services, except fuels
General contractors--residential bldgs, other than single-family
Operative builders
General contractors--industrial buildings & warehouses
Highway & street construction contractors, exc elevated highways
Commercial Banks
Credit Unions

This list of industries is instructive in that it is apparent that the difference in industrial structure of regions with and without broadband require more analysis. From this list it is clear

that some firms (commercial banks, travel agencies and cable TV) will require broadband for their routine operations. It is less clear to us why, for example, automobile parking requires broadband access. However, we are certain that in the time required to fully undertake a study of the transmission mechanism between broadband access and firm productivity that new technologies, applications or processes not yet defined may well render such a study moot.

What we believe this analysis tells us with some certainty, is that there was not (as of 2000) unassailable evidence that firm location decisions are heavily effected by the presence of residential broadband. However, it is an almost certainty that any productivity advantages offered by the presence of broadband may influence location decisions for firms in some industries. A more definitive finding regarding firm location and access to residential broadband will require further analysis.

## 5. *Summary and Conclusions*

The importance of affordably priced, widespread broadband telecommunications has sparked a huge amount of excitement among those who have glimpsed this technology's potential for transforming both commercial activities and the quality of residential life. Accordingly, for some, ubiquitous availability of broadband service and competitively-induced reductions in broadband prices cannot come quickly enough. As a result, there are numerous proposals for governmental intervention aimed at hastening the extension of broadband to areas where it is currently unavailable and at intensifying the level of competition in the provision of these communication services. Indeed, if there is anything that is ubiquitous, at this point, it is the excitement that broadband has spawned.

Unfortunately, many policy discussions are conducted in an environment where there is a paucity of factual information describing the potential benefits attributable to broadband telecommunications. This challenge is certainly not unique to West Virginia. However, recognizing the problem, West Virginia policy-makers commissioned the empirical investigation reported herein. Regardless of how one views the current study's methods or conclusions, the policy-makers who sponsored this work should be lauded for both their prudence and ambition.<sup>30</sup>

The economic impacts of broadband availability vary between commercial and residential users. Commercial users are interested in the technology's potential to increase productivity and reduce costs. Residential users are motivated by the way broadband increases the utility of household applications that are often related to entertainment.<sup>31</sup> Hence, the current analysis elected to treat residential and commercial benefits separately.

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<sup>30</sup> This concern was well expressed by Stanton [2004] that "The public policies currently being debated [regarding broadband] do not acknowledge this smaller [digital] divide nor do they acknowledge the emerging technologies for broadband access that will make it easier for remote areas to have high speed Internet connections. These factors will change the broadband policy debate." pg. 9.

<sup>31</sup> This was noted by Robert Gordon [2002] that "... American corporate business already has fast connections, and even college freshmen have lightning-fast access to the Internet from their dorm rooms. Whatever impact on business productivity made possible by universal adoption of broadband in the American corporate and institutional world has already occurred. A rush to install broadband connections in the American household would not have a direct impact on business productivity, since its major effect would be to allow faster downloading of video, music and games." pg. 47.

In terms of commerce, there is evidence that available broadband is important to specific business activities, mostly observable at present within the Services and Financial sectors, which depend more on the speed of broadband Internet access to perform multiple and frequent transactions essential to their operations. Moreover, firms within the industries where broadband access is viewed as a competitive advantage generally will not locate in areas where this access does not exist. On a state-wide basis, any extant lack of broadband access has not generated observable negative economic outcomes. This largely owes to the fact that broadband services (in some form) are already available to the vast majority of firms within the state. Moreover, while it is true that extending the current broadband networks might yield measurable benefits to additional commercial users, the magnitude of these incremental benefits pales when compared to the benefits already achieved without any policy intervention. Thus, while commercial concerns within individual communities may stand to gain from further network extensions, the state economy, as a whole, would see few changes.<sup>32</sup> The overall West Virginia economy is far more likely to be impacted by improvements in service speeds and/or pricing in those areas where broadband communications are already available.

With regard to households, there is growing national evidence that broadband telecommunications services have (or, at least, will) become the “fourth utility.” There is, however, consistent evidence that residential adoption rates are largely a function of education and age structure. This correlation very probably helps to explain the relative lack of concern evidenced by many of the households who participated in the survey conducted as a part of the current study effort.<sup>33</sup> The current set of dial-up Internet users would appear to represent the set of users that is most likely to yield new broadband subscribers. Yet of this group nearly one-third could not say definitively whether or not their household currently has access to broadband

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<sup>32</sup> The benefits to communities should also receive extensive scrutiny before serious public sector investment is undertaken. Broadband, and other information technology may be a necessary, but are not a sufficient condition for rural economic growth (see Fox and Porca 2001; Glasmeier and Howland, 2001; and Malecki [2001] in Drabenstott, Mark and Katharine Sheaff. “Exploring policy options for a new rural America--a conference summary.” Federal Reserve Bank of Kansas City, 2001.

<sup>33</sup> Whitacre (2001) notes when discussing efforts to close a ‘digital divide’ that “The most important [policy] form deals with working on the underlying characteristics between rural and urban areas, including attempts to increase education and income levels in rural areas.” pg 15.

services and the vast majority are making the decision to continue their dial-up services without even exploring the prices of any available broadband alternatives. These findings certainly do not instill any sense of urgency.<sup>34</sup> While the effects of income on subscription rates could be quickly overcome through public policy, the impact of educational deficiencies on broadband subscription rates will be much more difficult to remedy. Therefore, extending broadband networks into the most remote reaches of the state is likely to yield relatively few new users.

Barely 10 years ago the Internet was little more than a novelty familiar only to the technologically elite. In fewer years than it takes a new-borne child to reach kindergarten this technology emerged as one of the most powerful economic forces ever observed and it did so largely without public sector guidance. Today, at least domestically, there are very few (if any) lines of commerce that are not measurably different because of the emergence of Internet services. The impacts of the Internet on public sector activities and on home life have been no less profound.

Though networks now support millions of users and thousands of new applications, overall available capacity is plentiful. The past decade has seen increases in our computational and communications capacities that have outstripped demand-side growth. Moreover, the breathtaking growth in technological capacity, combined with competition has produced substantial declines in the pricing of both equipment and services. Indeed, in the final days of this nearly year long study, SBC communications announced a suite of broadband services would be made available of as little as \$14.95 a month.<sup>35</sup> While the current pace of technological progress may not be sustainable, there is little doubt that myriad improvements to equipment, software, and services are still forthcoming.<sup>36</sup> Care must be taken to avoid

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<sup>34</sup> This finding is echoed by a 2003 Congressional Budget Office study which concludes “Yet if the market for broadband is working tolerably well, as CBO’s analysis concludes, it is likely that consumer demand and market developments —uninfluenced by subsidies—will draw resources toward the production of a bundle of goods and services that will grant an even higher level of well-being.” Does the Residential Broadband Market Need Fixing? Congressional Budget Office, December 2003.

<sup>35</sup> Searcy, Diane “New Low Price for Broadband” Wall Street Journal, Wednesday, June 1, 2005. At this price, dial-up service would seem to be on its way out.

<sup>36</sup> The Journal Report: Technology, May 23, 2005.

investment in technology that could become quickly outmoded. This cautionary note should be especially relevant to governments seeking investments that will constrain future choices without the discipline of markets.<sup>37</sup>

Far from ignoring what amounts to a technological revolution, West Virginians have participated in it. There is no evidence that availability to commercial users within the state has been an impediment to the adoption of broadband. There is also no indication that the roll-out of these services elsewhere has been timelier or less troublesome. While it is true that 12 percent of zip codes within the state have no broadband access, this figure does not compare unfavorably with a number of rural states in the Midwest and western United States. Moreover, 30 percent of West Virginia zip codes have three or more providers, while 54 percent have at least two. However, in West Virginia, residential use of the Internet is measurably below the national average (50 percent versus 66 percent), and of those households who do subscribe to some form of Internet service, broadband usage (42 percent) is lower than the national average of 51 percent.

In summary, broadband access in West Virginia is not as extensive as it is in more affluent and more densely populated states. Still, there is no substantive evidence of any widespread deficiency. There are, no doubt, isolated instances in which either commercial or residential users have unmet demands. The problem does not, however, appear to be widespread. Accordingly, the magnitude of the potential benefits from more extensive service offerings, particularly to residential users, appears to be relatively small.

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<sup>37</sup> And, though economic analysts from Adam Smith onwards have provided breathtaking underestimates of adoption rates of new technologies, government planners not infrequently make economists appear remarkably prescient.

## ***6. Postscript***

The analyses described in the above text represent a very preliminary examination of a nascent and rapidly changing technology. We have concluded that West Virginia is enjoying economic benefits associated with the currently available technologies that are similar in nature and magnitude to the benefits accruing to the nation as a whole. For this reason, we have suggested that direct, broad-based state intervention in broadband markets is not warranted at this time. This does not mean that there is no need for an active state broadband policy. To the contrary, the magnitude of the successes enjoyed to date underscores the potential benefits from public policies that actively preserve current gains and encourage future progress. Specifically, we believe the state should consider the following courses.

- **An Investigation of the Links Between Broadband and Healthcare** The State of West Virginia heavily subsidizes both the public and private provision of healthcare services. Increasingly, broadband is used in the transmission of medical data and billing information. Understanding the linkages between healthcare and rural broadband availability could substantially increase the State's future ability to control healthcare costs and improve the quality of services.
- **Development of a Monitoring Program** Again, the current analysis suggests that state policies have been effective given current technologies, but in an area where change is so abundant, the state should continuously monitor market conditions and outcomes to ensure that success is continued.
- **Data Development** Early criticisms of the current analyses largely rest on the accuracy and timeliness of the FCC data used in many portions our work. Better data describing the specific broadband services that are available at precise geographic locations (including price data) would lead to more universally accepted analytical outcomes.
- **National Policy Analysis** There will likely be national telecommunications legislation within the foreseeable future and this legislation will almost certainly consider regulatory changes in the provision of broadband. West Virginia would be well advised to investigate these potential regulatory changes now in order to determine which potential changes are desirable from a West Virginia perspective and which are not.

- **Continued Advocacy on the Behalf of Communities** We see no evidence that broadband availability is a statewide problem requiring broad-based government intervention. There are, however, any number of communities in which a localized lack of broadband availability is viewed as an impediment to economic development. Very often state agencies have taken on the role of advocate as the communities negotiate with potential providers. This is very likely a useful state function.

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