Measuring Broadband’s Economic Impact*

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Measuring Broadband’s Economic Impact

• Why does it matter?
• Context: current state of research...
• Results
• Methods and Data (and caveats…)
• Next Steps
Broadband’s Economic Impact?

• Future is Broadband so Comm Policy must be BB policy

• Broadband is really local.
  – Viability of, technology for, and extent of facilities-based competition varies geographically quite a lot. Aggregate data (Korea v. US, NY v. Alabama) leads to incomplete and misleading conclusions.
  – No one-size-fits-all policy makes sense: we believe Municipal BB can make sense but it matters critically how Munis are involved and what they should do depends on local context.
  – Wireless in some places (rural WISPS, hot spots in some urban areas) and conduit or even infrastructure in others (e.g. Burlington VT).

• Good targeted policy requires good data on BB impacts.
  – Targeting private (Wiley) or public (Hundt) investment for BB depends on information to assess performance of past investments.
  – BB Virtuous Cycle: Successful ICT investment leads to more investment and the reverse is true too (e.g., Y2K)

• Most of the BB research to date has focused on why/where of Digital Divide but not the “but does it matter”…
Progression of BB Impact Studies

- **1G**: Prospective, hypothetical
  - Crandall & Jackson (Verizon): BB to add $500b to GDP by 2006
  - Pociask (New Millenium Research Council): BB to create 1.2m jobs
  - Ferguson (Brookings): Lack of BB to lower productivity growth by 1% annually

- **2G**: Case studies, individual communities
  - Kelley: Cedar Falls, Iowa (muni bb since 1997) improved vs. neighboring Waterloo
  - Strategic Networks: S. Dundas, Ontario (muni fiber since 2000) grew sales, jobs, tax revenues

- **3G**: Controlled, statistical, larger geographic scope
  - Ford & Koutsky (Applied Economic Studies): Retail sales grew in Lake County, Florida (muni bb since 2001) vs. 10 control counties
  - This study: U.S. national scope, compares 2002 economic indicators by zip code, based on FCC report of BB availability by 1999

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Studying the Impact of Broadband

• **What we’d like to have:**
  – fine grained information on broadband deployment and use beginning with the first deployments in the early 90’s
  – Detailed economic data on amount and composition of employment, by demographic group, and by firm
  – Ten years or more of perspective to see impacts which develop over time

• **What we do have:**
  – Crude information on the availability of broadband, by zip code, beginning in 1999 when almost 60% of zip codes already have broadband
  – Census business survey data providing limited information on economic outcomes through 2002

• **Biggest challenge: Causality issue**
  – Distinguishing cause and effect:
    • is broadband deployed preferentially in economically successful communities? or
    • does broadband availability improve economic performance?
  – Especially an issue given limited time horizon of data (some methods not applicable)
Key Findings

• National data supports the conclusion that broadband positively affects economic activity
  – Even after controlling for community-level factors known to influence BB availability and economic outcomes
  – Controls: urban, income, education, growth in previous period

• Communities where mass-market BB was available by December 1999 experienced more rapid growth by 2002 in:
  – Jobs (employment)
  – Number of businesses (overall)
  – Businesses in IT-intensive sectors

• Property values higher in 2000 where BB available by 1999
  – Higher market rates for rental housing in 2000
  – Rents reported more accurately than home values in Census data
### Estimated Magnitude of Impacts

<table>
<thead>
<tr>
<th>Economic Indicator</th>
<th>Results (zip code comparison)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment (Jobs)</td>
<td>BB added about 1% to growth rate 1998-2002</td>
</tr>
<tr>
<td>Wages</td>
<td>No statistically measurable impact observed by 2002</td>
</tr>
<tr>
<td>Housing Rents (Proxy for Property Values)</td>
<td>More than 6% higher in 2000 where BB available by 1999</td>
</tr>
<tr>
<td>Business Establishments (Proxy for Number of Firms)</td>
<td>BB added nearly 0.5% to growth rate 1998-2002</td>
</tr>
<tr>
<td>Industry Mix</td>
<td>BB added over 0.5% to share of establishments in IT-intensive sectors, 1998-2002</td>
</tr>
<tr>
<td></td>
<td>BB reduced share of small establishments by about 1%, 1998-2002</td>
</tr>
</tbody>
</table>
Preliminary issues and working assumptions…

• Measuring economic impact of ICT is difficult
  – “Information Productivity Paradox”: need good micro data to resolve!
    • Cannot measure economic output of ICT (service sector)
    • Poor measures of inputs (rapid depreciation, lack of usage metrics → availability poor proxy)

• Broadband is local
  – State-level data is too aggregated. Economic output metrics lacking.
  – Lots of variability in quality, accessibility, penetration → and we observe only availability

• Impact is complex and takes time to reveal itself
  – Changes internal business process, impacts entry/exit decisions, changes prices.. all at different time scales.
  – Enhances/complements labor (increased productivity) and capital/labor substitution
  – Changes competition (local reach national markets, national markets serve local)
  – But, lag in economic impact provides hook to measure economic impact…
    • Penetration S-shaped adoption
    • Economic effects revealed over time
Empirical Literature on Productivity Paradox

• Macroeconomic studies (industry-level)
  – ICT intensive industries experienced slower growth (1980s-1990s)
  – ICT changes how businesses operate (relative prices, production processes, product strategy, human resource management, geographic location of business) ➝ industry structure… and,
  – That takes time….differs by business context (industry, firm, geography, ICT maturity)…
  – Too aggregate data won’t show it…

• Micro-data econometric research
  – Firm-level data solves aggregation problem (Brynjolfson; Lichtenberg & Lehr; et al.)
  – Better data about how ICT being used by industries and firms (Greenstein et al.)
  – Labor productivity studies (Katz & Murphy; Autor, et al.)
  – Macro studies with later data (Jorgenson; Stiroh, et al.)

• Bottom-up studies
  – Net impact studies (Cisco)
  – Value of broadband (Crandall & Jackson)

• Digital divide literature
  – Where is BB available, etc. (Gillett, Lehr, Osorio; Flamm; et al.)
Methods and Data

• (A) State and (B1 & B2) Community (zip-code) level panels
  – State too aggregated, provided as control. Focus on Zip Codes.

• Dependent variables:
  – Employment, Wages, Industry NAICs composition, Establishment Size

• Independent variables:
  – Broadband: Available in community as of Dec99 – Yes/No
    • “available” may not mean available everywhere within a zip code
  – Controls: Lagged dependent, Per Capita Income, Education, Size, Type of Community (Urban), etc.

• Issue: causality.. does BB cause or follow economic activity?
  – At one level, maybe we don’t care…if consumption good, still signals increased surplus associated with BB
  – However, would like to infer that BB drives economic activity

• Strategy: (A & B1) Linear Regression; (2) Matched Panel Regressions
## Data Sources

<table>
<thead>
<tr>
<th>Type of Data</th>
<th>Description</th>
<th>Availability</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Activity Indicators</td>
<td>Used for employment, establishments, wages (payroll), industry sector and size mix. Reported at zip code level; aggregated for state-level analysis.</td>
<td>Collected annually; most recent data from 2002. Industry sectors coded by SIC (1994-7) and NAICS (1998-2002).</td>
<td>U.S. Census Bureau - ZIP Code Business Patterns (ZCBP)(^\text{19})</td>
</tr>
<tr>
<td>Demographic Indicators / Controls</td>
<td>Used for income, rent, educational attainment, and # of households. Reported at both zip code and state level. Also used to compute % of population in urban areas for state-level analysis.</td>
<td>Collected every 10 years; most recent data from 2000.</td>
<td>(1) U.S. Census Bureau - 2000 Decennial Census (2) GeoLytics – CensusCD (&quot;1990 Long form in 2000 boundaries&quot;)(^\text{20})</td>
</tr>
<tr>
<td>Geographic Controls</td>
<td>Used to indicate how urban or rural a zip code is, based on its population and proximity to metropolitan areas.</td>
<td>Computed every 10 years; most recent coding from 2003.</td>
<td>Economic Research Service, U.S. Department of Agriculture - Urban Influence Code (UIC)(^\text{21})</td>
</tr>
<tr>
<td>Broadband Metrics</td>
<td>Reports number of high-speed Internet providers by zip code, and number of lines in service by state.</td>
<td>Collected every 6 months (end of June and December) since 12/1999.</td>
<td>U.S. Federal Communications Commission - Form 477 databases(^\text{22})</td>
</tr>
</tbody>
</table>
Table 7: Broadband Impact on Growth of Selected Economic Variables

(+/- = growth higher/lower in broadband communities; *= significant at 90% or above)

<table>
<thead>
<tr>
<th></th>
<th>State 25</th>
<th>Zip</th>
<th>Matched Panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment</td>
<td>-/+*</td>
<td>+*</td>
<td>+*</td>
</tr>
<tr>
<td>Wages</td>
<td>+/-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Rental rates</td>
<td>+*</td>
<td>+*</td>
<td>+</td>
</tr>
<tr>
<td>Establishment</td>
<td>+/--*</td>
<td>+*</td>
<td>+</td>
</tr>
<tr>
<td>IT-intensive share of</td>
<td>-/+*</td>
<td>+*</td>
<td>-</td>
</tr>
<tr>
<td>establishments</td>
<td></td>
<td></td>
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9. Employment - Table 9A: Employment - State Level Regressions

<table>
<thead>
<tr>
<th></th>
<th>(9A1) LnrEmplo</th>
<th>(9A2) LnrEmplo</th>
<th>(9A3) LnrEmplo</th>
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</thead>
<tbody>
<tr>
<td>BBPen00</td>
<td>0.44262</td>
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<td></td>
<td>[0.88115]</td>
<td></td>
<td>[0.81443]</td>
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<td>SqBBPen00</td>
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<td>7.43397</td>
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<tr>
<td></td>
<td>[10.00182]</td>
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<td>[9.07825]</td>
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<td>gEmp9498</td>
<td>0.3912</td>
<td>0.41257</td>
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</tr>
<tr>
<td></td>
<td>[0.10807]***</td>
<td>[0.11250]***</td>
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<tr>
<td>pUrbPop00</td>
<td>0.03577</td>
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<td>[0.03221]</td>
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<tr>
<td>Constant</td>
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<td>Observations</td>
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<td>48</td>
<td>48</td>
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<tr>
<td>R-squared</td>
<td>0.0531</td>
<td>0.2801</td>
<td>0.2985</td>
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</table>

Standard errors in brackets
* significant at 10%; ** significant at 5%; *** significant at 1%
Table 9B: Employment - Zip Code Regressions

<table>
<thead>
<tr>
<th></th>
<th>(9B1) InrEmplo</th>
<th>(9B2) InrEmplo</th>
<th>(9B3) InrEmplo</th>
<th>(9B4) InrEmplo</th>
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<tr>
<td>BB99</td>
<td>0.03344</td>
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<td>dUrban</td>
<td>0.05854</td>
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<td>[0.00493]***</td>
<td>[0.00507]***</td>
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<tr>
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<tr>
<td>R-squared</td>
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<td>0.0028</td>
<td>0.0271</td>
<td>0.0273</td>
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</tbody>
</table>

Robust standard errors in brackets. State dummies are not shown in table. * significant at 10%; ** significant at 5%; *** significant at 1%
### Table 9C: Employment - Zip Code nnmatch regressions

| Variable     | Coefficient | z-statistic | P>|Z| |
|--------------|-------------|-------------|-----|
| lnrEmplo     | 0.0534799   | 2.97        | 0.003 |

<table>
<thead>
<tr>
<th>Variable</th>
<th>Treatment BB99=1</th>
<th>Control BB99=0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Dev.</td>
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<tr>
<td>lnrEmplo</td>
<td>0.0258269</td>
<td>0.3078458</td>
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<td>gEmp9498</td>
<td>0.3055394</td>
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<tr>
<td>URinfl03</td>
<td>4.252051</td>
<td>2.90324</td>
</tr>
</tbody>
</table>
Conclusions

• #1 Results support view that broadband access does enhance economic growth and performance, and that the assumed (and oft-touted) economic impacts of broadband are real and measurable.

• #2 Analysis is perforce preliminary because data limited...support will be stronger with better data, but analysis will be moving target because

• #3 As BB becomes more uniformly available...becomes competitive necessity rather than advantage for any given locality.

• #4 Future will need to focus on how BB is being used, how BB is changing competitive dynamics, and opportunities/challenges for policy
  – What factors complement BB? How does BB change economic activity over time?
  – How much BB is necessary? Is too much?
  – Intermodal/cross-platform competition (e.g., Cable v. DSL v. 3G v. BPL; FTTH?)
  – Implications for interconnection & open access (e.g., BITS legislation, etc.)
Potential Next Steps

• Further refinements to methodology
  – Pursue data for instrumental variables as alternative approach to causality issue

• Incorporate additional data of economic impacts/effects
  – Integrate data from other panel sets (enterprise H&H, CPS data)
  – Additional metrics of economic impacts (voting behavior, eGov metrics, self-employment)
  – Survey data (industry association panel)
  – Case study research on BB impacts

• Incorporate better data of BB use
  – Penetration and QoS of BB data? (Generation of technology)
  – FCC? States? Private (e.g. Pew)?

• Business and industry structure modeling
  – BB scenario development
  – Systems dynamics analysis
  – Open access (wholesale v. retail competition, platform competition)