Predicting Broadband Effects

A new type of statistical model helps cities estimate broadband's effects on their economic well-being.

Many studies connect broadband to national growth in income, employment or other indicators. There is also plenty of anecdotal evidence about cities that have attracted jobs through better broadband – or have been passed over by site selection committees because their broadband wasn't good enough.

Inspired by these studies and anecdotes, localities have invested in broadband infrastructure, either directly or through various partnerships with private providers. Their results have been mixed. Some have achieved dramatic turnarounds in their local economies, most have seen at least some positive effects and others have little to show for their efforts.

This variation may reflect differences in how well the networks are built, operated and marketed. There's also evidence that broadband is more effective when it's part of a coherent economic development strategy.

However, there may also be inherent differences among cities that affect their potential gains from better broadband. But until now, there has been no way to predict results for any particular city. Are there cities that *can't* benefit from an investment in broadband? Conversely, are there cities for which investing in broadband is an especially good bet?

How can a city know whether an investment in broadband will be justified by increased tax revenues, employment or wages?

BRIDGES TO NOWHERE?

In 2005, the Alaskan congressional delegation secured more than $200 million in federal funding for a bridge between Ketchikan and Gravina Island, which has 50 residents. (To be fair, the island also has an airport.) Widely ridiculed as the "bridge to nowhere," the project was never constructed, and then-governor Sarah Palin canceled the state matching funds in 2007. Whether the bridge would have boosted the development of Gravina Island will never be known, but most Alaskans had a hard time imagining that it would.

A few years later, political opponents picked up the phrase "bridge to nowhere" to criticize the broadband stimulus programs in the American Recovery and Reinvestment Act. In retrospect, most of the networks these programs funded appear to have yielded positive economic results, but funding recipients couldn't demonstrate that they *weren't* building to the broadband equivalent of Gravina Island. Nor could funding agencies judge which applications would yield the biggest bang for the buck, economically speaking.

Now, researchers at the University of Connecticut, with assistance from the state broadband office, have developed a model that predicts city-level benefits from increased broadband speeds. The model won't produce numbers that cities can "take to the bank," but it can be useful for two purposes: first, reassuring municipal governments that they are *not* building bridges to nowhere; second, helping state funding agencies prioritize broadband projects.

Elin Swanson Katz, agency head of the Connecticut State Broadband Office, who initiated the project in 2015, says, "Working with the state economic development agency, we were delighted to have the opportunity to support the efforts of Sudip Bhattacharjee and his students in developing this unique statistical analysis tool for a question that has hampered the efforts of towns and investors alike: Does the introduction of a fiber network in a town actually provide benefits in excess of the costs of creating it? The model is a giant first step toward creating an objective tool for predicting an accurate answer to that essential question."

> The cities most likely to benefit from broadband are mid-sized cities, not too far from bigger cities, with multiple broadband providers and younger populations.

BUILDING THE MODEL

Researchers began by defining and measuring broadband quality, economic outcomes, and other relevant characteristics. Like all economic models, this one is limited by data availability, so researchers didn't have access to every measure they might have wanted – such as broadband prices or even the precise number of broadband providers in a town.

Briefly, they defined broadband quality by average upload and download speeds (as measured by Ookla), the (approximate) number and type of broadband providers, and the percentage of households connected.

Economic outcomes used were median household income, number of annual housing permits, average wage, employment, and property tax revenue. All five outcomes were provisionally given equal weight. State and local governments that use this model can choose to predict a subset of these outcomes and/or assign different weights to the outcomes, depending on their preferences and values.

When they examined a sample of 62 Connecticut towns over the 2008–2013 time period, the researchers found that broadband quality was indeed related to economic outcomes. But did broadband quality affect the local economies, or vice versa? A fortuitous sudden bump in broadband speeds when Comcast and Cox converted to DOCSIS 3.0 showed definitively that the direction of causality ran from broadband to economic outcomes. (This part of the study is described in a second paper, which is yet to be published.)

In addition to broadband quality, the researchers considered many other variables to find out what might affect the cities' responses to improved broadband. Ultimately, because many of these variables were closely correlated, the researchers reduced the number to a minimum. The three that appeared most significant were size category (small, medium, large), distance from the nearest big city and median age.

Using these variables, the researchers used data from any 52 towns to calculate the effect of raising broadband speeds to 50 Mbps/15 Mbps or 100 Mbps/25 Mbps on each of the five economic variables and on a combined economic index. They then applied the model to the remaining 10 towns in the sample to see how well it predicted their experiences. This process was repeated multiple times, using different towns in the 10-town validation set. The average predictive value over the six-year period was 86 percent. The economic indicator most accurately predicted was tax revenue.

MEDIUM-SIZED TOWNS BENEFIT MOST

The researchers found that the same broadband speeds affect different towns in different ways.

- Most towns benefit economically from internet speed increases.
- Medium-sized towns benefit most, followed by small towns and then by big cities.
- A few small towns actually suffer economically from increased broadband speed. These towns have relatively fewer broadband providers, have higher median ages and are located farther from big cities. The difference in the number of broadband providers (both fixed and mobile) is most striking.

The researchers speculate that big cities benefit less from broadband speed increases because they already have relatively good infrastructure and internet speeds, so the marginal economic benefit of introducing more high-speed internet is low.

Medium-sized and small towns, on the other hand, have low average broadband speeds, so raising their speeds to 50 Mbps or 100 Mbps represents a sizable jump more likely to have an impact.

Differences in benefits among the medium-sized and small towns, the researchers say, reflect which towns are best poised to take advantage of increased broadband speeds. Towns that are far from metropolitan centers and have aging populations are not attractive to employers, even if they have good broadband. And if they have few broadband providers, their broadband prices will likely be high, negating some of the benefit of high-speed broadband.

Sudip Bhattacharjee, the lead researcher from the University of Connecticut, explains that increased broadband speed "doesn't suddenly change the economics of the town; there have to be businesses that can use it."

USING THE MODEL

Several cities and states are already considering using this predictive model. How they do this will depend on their similarity to the cities studied in Connecticut. Bhattacharjee says, “If the new city looks similar to the cities in the study sample, they wouldn’t have to redo the model – they could just plug in their numbers. However, if their demographics or other factors are very much out of our sample – for example, if they were extremely rich or extremely poor – they would probably need to re-estimate the model.”

He cautions that regional differences will also have to be taken into account. For instance, in densely populated Connecticut, residents often work in cities they don’t live in. In Texas, this is less likely to be true.

Bhattacharjee believes the model will be most useful as a planning tool for states. He says, “If municipalities make their own decisions, they are locally optimizing for themselves but not globally optimizing for the state. The big picture for the state might be different.” If a state can predict which cities will benefit most from broadband investments, it can direct funding to those cities and use the gains from tax revenues to fund later investments in the remaining cities.

Bill Vallee, state broadband policy coordinator for the Connecticut Broadband Office, sums up the findings as follows: “In trying to develop a basic toolkit for Connecticut towns to use in preparing financial and marketing materials in the effort to attract fiber project investors, it is key for towns to more fully recognize the actual risks and rewards that are possible from a long-term investment in a fiber project. Though elected leaders are experienced with more common infrastructure projects, fiber presents a unique model that requires specialized due diligence and effort. We’re hopeful that this UConn statistical model will become far more developed as an essential tool, especially as more refined data is generated and utilized over time.” ❖

For more information, see “Predictive Models to Measure the Impact of Fiber-Optic Broadband Speeds on Local Towns And Communities,” by Aindrila Chakrabortya, Sudip Bhattacharjee, James R. Marsden, Ramesh Shankara, Elin Swanson Katz and William L. Vallee Jr., *Telematics and Informatics* 35 (2018), pp. 1408–1420.