Broadband and e-Government Diffusion

Enrico Ferro
Istituto Superiore Mario Boella
ferro@ismb.it

Daniele De Leonardis
Istituto Superiore Mario Boella
deleonardis@ismb.it

Lucy Dadayan
University at Albany, SUNY
ld8318@albany.edu

Abstract

This article focuses on the relationship between e-Government services and broadband connections. The importance of broadband availability for a sound economic development has been advocated by both the academic and political world; however little evidence has been provided as to its impact on e-Government. The paper consists of two main parts. The first part provides a brief literature review of broadband diffusion and impact. The second part provides a comprehensive understanding of the impact of broadband on e-Government demand and supply in Italian region called Piedmont. The third and final part analyses the broadband diffusion process occurred in the last five years in Piedmont.

1. Introduction

In the last five years various studies conducted by prominent research centres have pointed out the important social and economic impacts of a widespread use of broadband connections in terms of information access and business opportunities [2, 12]. These arguments were taken into consideration by the European Union through the inclusion of the availability of broadband networks among the priorities listed in the eEurope strategic plans.

While little doubt remains about the role played by broadband for sustainable economic development, it is still unclear how to obtain a widespread and economically accessible diffusion of such networks. The trend of liberalization of telecommunication (TLC) markets that occurred in the nineties throughout most of the western world represented a shift from a logic based on the concept of natural monopoly to a more market driven approach. Such a shift created a strong accent on efficiency and economic feasibility aspects, and had a significant impact on the investments' allocation necessary for building network infrastructures. Consequently, the diffusion process has been characterized by a high level of heterogeneity, where considerable portions of the population are not reached.

Without discussing in detail the theme of digital divide, it has a significant impact on certain underprivileged areas or population groups due to limited access to information. In this respect, the award of the 2001 Nobel Prize in Economics for a study demonstrating how information asymmetries may be used to gain economic advantages, reinforces this thesis and underlines the importance of information access as an essential element to guarantee conditions of fair opportunity. Thus, it is reasonable to believe that even though the diffusion process of broadband networks is based on a market approach, it cannot be completely separated from a concept of service universality.

The existence of a direct relationship between the presence of broadband networks and availability of e-Government services has frequently been debated in the literature. Nevertheless, little research has focused on understanding and quantifying such a relationship [12]. Most of the academic effort has been directed towards investigating how Local Public Administrations may act as demand aggregators in order to attract TLC couriers' investments [5, 9] or to measure the impact of broadband on economic development in general, and on employment in particular [2, 12]. However, little attention has been devoted to understand what impact the presence of broadband networks may have on the availability and usage of e-Government services at local level.

Thus, the aim of this article is twofold. First, to understand to what extent the presence of broadband networks influences the availability and use of e-Government services. Second, to investigate the main determinants of broadband infrastructures diffusion in order to understand whether and how wireless technologies may help such diffusion.

2. Methodology

An important methodological question in the analysis of broadband diffusion is the definition of the object of study itself. One can find a number of different definitions of broadband in the literature, some of which rely on a list of applications, while others on levels of interactivity. However, none of the definitions is generally accepted. According to Canadian National Broadband Task Force (NBTF), "a study of international broadband initiatives done for the Task Force found that common usage of the term "broadband" is not this precise, and ranges from a low of 200 thousand bits per second (Kbps) to as high as 30 Mbps in the 14 countries that were studied" [1].

For the purpose of this article, broadband will be referred to as Internet connections with a downstream nominal speed equal or greater than 640kb/s. This choice is mainly driven by the necessity to obtain a methodological homogeneity in the analysis of data collected from different sources.

The analysis was carried out on an Italian region named Piedmont with the aim to study the relationship between broadband and the presence of e-Government services identified by the European Commission as having priority. In order to get a firm grasp of the subject, data was collected on variables reflecting both demand and supply related aspects of e-Government services. This methodological choice provided a multifaceted representation of the problem as well as allowed drawing grounded conclusions based on both qualitative and quantitative data.

E-Government services' supply related data was collected through face-to-face interviews conducted with the regional managers of the major TLC couriers operating in Piedmont region. We collected both qualitative and quantitative data during these interviews.

E-Government services' demand related data was collected through surveys from the following three main socio-economic actors:

1. Government users (municipalities)
2. Residential users
3. Business users (enterprises)

Throughout the survey we adopted stratified random sampling strategy and used the following stratification criteria: size of local public administrations (based on the number of residents); age and gender for residential users; type of activity and size for business users (based on the number of employees).

Table 1. Survey sample and data collection methodology

Survey	Sample	Population	Data Collection Methodology
Government users	275	1,206	Written Questionnaire
Residential users (over 16 years old)	1512	4,214,677	Phone Interviews
Enterprises with over 10 employees	379	6,324,567	Written Questionnaire

Table 1 provides detailed information on the sample size and data collection methodology adopted for the study.

3. Literature Review

3.1. Broadband diffusion

The diffusion of broadband connections represents a complex phenomenon which is attributable to the broadband demand and supply relationship as well as to the relationship between broadband technologies and other economic activities. In the literature on the diffusion of broadband technologies three main streams of research may be found, all of which mostly focus on demand related aspects.

The first stream of research is targeted towards discovering the role of socioeconomic variables (such as income, education, age, gender, etc.) on adoption and usage of broadband connections in order to understand and control for the formation of potentially dangerous information asymmetries among the population that could lead to the rise of digital divides [7, 8, 10, 13].

The second stream of research focuses on the role of public administrations as catalysts for attracting infrastructure investments by telecommunication couriers. Factors leading local communities to undertake broadband initiatives and the consequences these initiatives had on the local economy are particularly emphasized in this stream of research [9, 11, 12].

Finally, the third stream of research aims at identifying whether the so-called "Killer Applications" contribute to faster and widespread penetration of broadband. Most researchers and practitioners argue that email is the biggest broadband killer application, which is a low bandwidth application. However, it is still debated whether broadband diffusion is due to killer applications driving broadband demand or due to users' mature use of Internet.

3.2. Broadband impact

The impact of broadband can be analyzed in three different contexts: economic, political, and social. In the economic context broadband impact is measured in terms of efficiency, productivity and economic growth. In the political context, broadband has an impact on e-democracy and promotes democratic forum in the cyberspace. Finally, in social context, broadband diffusion leads to a better quality of life, by providing better healthcare, expanded education opportunities, increased responsiveness by governments to the citizen needs.

Bauer et al. provided detailed description of potential benefits of broadband in seven areas: communities and society at large, telemedicine, e-learning, e-Government, e-business, telecommuting, and media and entertainment [3].

Evaluating the broadband impact is challenging, and as Lehr, et al. noted, "Measuring the economic impact of broadband is difficult and confronts the same types of measurement challenges that led to the so-called Productivity Paradox of Information Technology" [12]. The impact of broadband is associated with other factors, including IT, organizational and cultural change, etc. [4, 11]. The research conducted by Crandall and Jackson is one of the few studies that attempts to assess the magnitude of broadband impact. In their study, Crandall and Jackson used two estimation procedures to calculate the economic benefits realized from broadband diffusion. In the first approach, the authors used a prospective demand function for high-speed access and calculated the consumer surplus associated with that demand function. Moreover, the authors included the broadband benefits both to consumers and to producers. In the second approach, the authors attempted "to identify the sources of the specific benefits that broadband access can provide and to calculate the consumer surplus associated with such benefits" [6]. Based on the results of the both estimations, Crandall and Jackson concluded that the adoption of broadband will have a significant impact on the economy, even though many of the impacts cannot be readily foreseen.

The literature review on broadband impact illustrates the trend of academic research towards identification of efficient diffusion policies rather then understanding and quantifying the impact of broadband. The field of e-Government makes no exception. The importance of broadband for the development of e-Government has been heralded by both the political and the academic world. But such enthusiasm has not been supported by hard figures yet. Thus, we attempt to make a contribution to the literature by investigating the relationship between broadband and e-Government demand and supply.

4. Broadband and e-Government

The goal of this section is to investigate the relationship between broadband and e-Government services. In other words, to what extent the lack of broadband coverage represents a barrier to the provision and usage of e-Government services. The first part of this section discusses supply related aspects at municipal level, while the second part of the section focuses on the use of e-Government services by enterprises and the general public.

4.1. The impact of broadband on the supply of e-Government services

In order to understand the impact of broadband on the supply of e-Government services, we first considered municipalities offering e-Government services based on two types of connections: broadband and narrowband. As Figure 1 below depicts, there is a significant gap between municipalities adopting a broadband connection and municipalities still connected through a narrowband connection in terms of provision of e-Government services. While 77% of municipalities connected through broadband provide e-Government services to different stakeholders, only 46% of municipalities connected through narrowband provide e-Government services. This 30% gap is an indicator of a correlation between broadband adoption and availability of e-Government services provision.

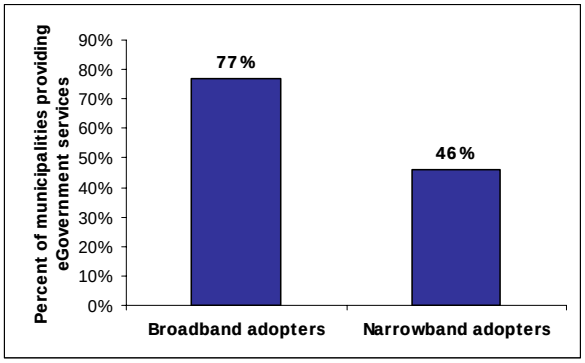

Figure 1. Supply of e-Government services by type of Internet connection

It is important to note that 85% of municipalities offering e-Government services through narrowband connections are not covered by broadband. For this reason it's necessary to distinguish between two types of municipalities:

- Municipalities that consider a narrowband connection suitable for offering e-Government services, despite the availability of broadband coverage, and
- Municipalities that are forced to use a narrowband connection for providing e-Government services due to the lack of broadband coverage.

In order to account for this difference, the variable *broadband availability* was included in the analysis. Thus, municipalities not reached by broadband infrastructures were excluded from further analysis. This helped to understand to what extent municipalities considered narrowband connections suitable for the provision of e-Government services.

Only 17.7% of municipalities providing e-Government services considered a narrowband connection adequate for the provision of e-Government services, while 82.3% of municipalities favoured broadband connection for providing e-Government services (see Figure 2). These results suggest that lack of broadband coverage to some extent may represent a barrier to the diffusion of e-Government services.

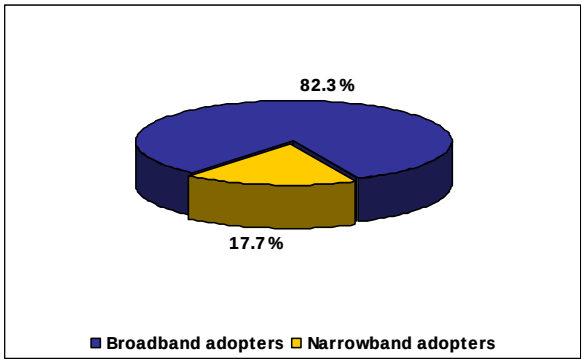

Figure 2. Municipalities reached by broadband infrastructure

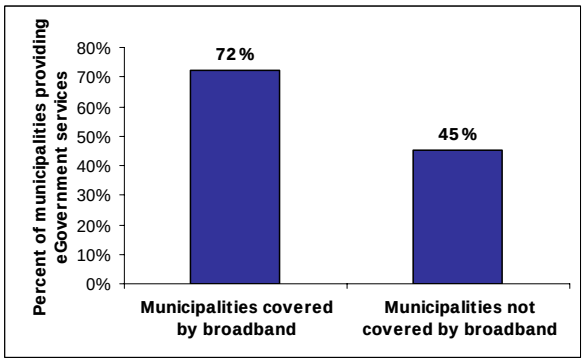

Figure 3. Broadband network coverage across municipalities

A further distinction thus was made in terms of e-Government services provision between local administrations based in a territory not reached by broadband infrastructures and those based in a territory covered by broadband. Again, the results obtained suggest that the lack of broadband coverage strongly discourages the provision of e-Government services among local administrations (see Figure 3).

We conducted a further data analysis in order to understand whether the relationship found between the presence of broadband infrastructure and availability of e-Government services may stem from an indirect influence due to a correlation between the size of the municipality and the two variables in question: broadband coverage and e-Government service availability. Thus, we included the size of the municipality (measured by the number of residents) as a control variable. As Figure 4 depicts, despite the correlation between the municipality size and availability of e-Government services, the presence of an impact of broadband availability over the provision of e-Government services persists.

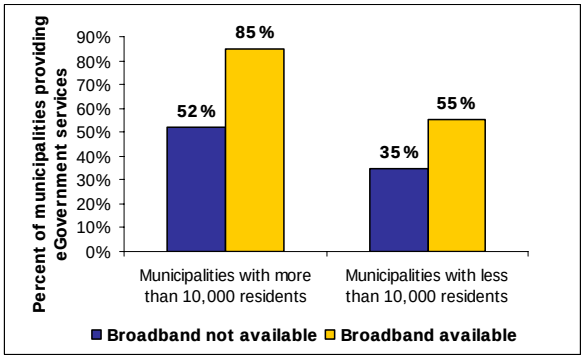

Figure 4. Broadband network coverage by municipality size

4.2. The impact of broadband on the demand of e-Government services

The analysis of the impact of the broadband on the supply of e-Government services was followed by the analysis of the impact of the broadband on the demand of e-Government services. First, we tried to uncover whether the availability of broadband connections had an influence on enterprises and residential users' behaviour in terms of e-Government services use. We found a consistent correlation between broadband adoption and higher use of e-Government services across enterprises of varying sizes (see Figure 5).

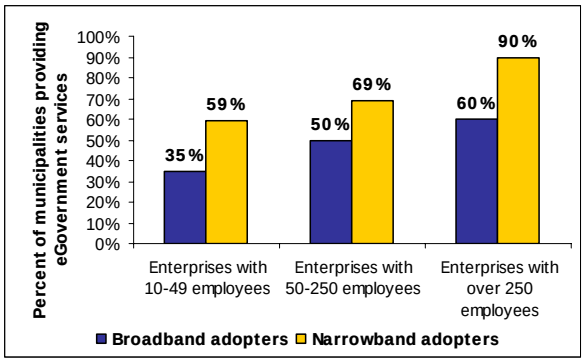

Figure 5. Broadband network coverage by enterprise size

For most government operations, "broadband is necessary considering the large volume of electronic data transferred each day" [3]. As Figure 6 depicts, there is a statistically significant correlation between broadband adoption and higher use of e-Government services among the citizens.

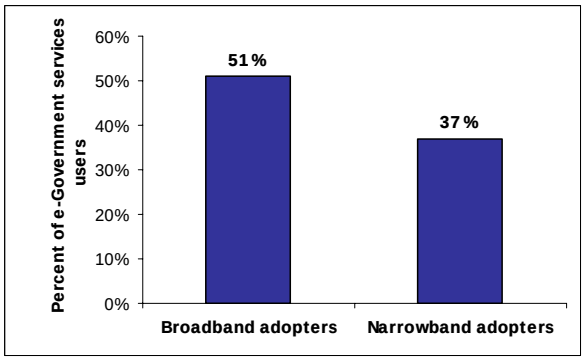

Figure 6. Broadband network coverage among citizens

To sum up, the evidence presented in this section of the paper suggests that broadband has a significant impact on the use of e-Government services in terms of both demand and supply as well as across different user groups.

5. Evolution dynamics of the broadband infrastructure in Piedmont

A robust analysis of the relationship between broadband and e-Government services may not be decoupled from a deep understanding of the infrastructure diffusion process. Thus, we analyzed the evolution dynamics of fibre optic and DSL networks in Piedmont in an attempt to identify main determinants, enablers, and barriers of broadband diffusion.

Figure 7 represents the situation of network infrastructure diffusion in Piedmont, Italy as of 2005. From a first glance it is possible to observe that only a limited percentage (about 24%) of the municipalities is reached by xDSL services. However, in terms of population, this translates in over 70% of the population.

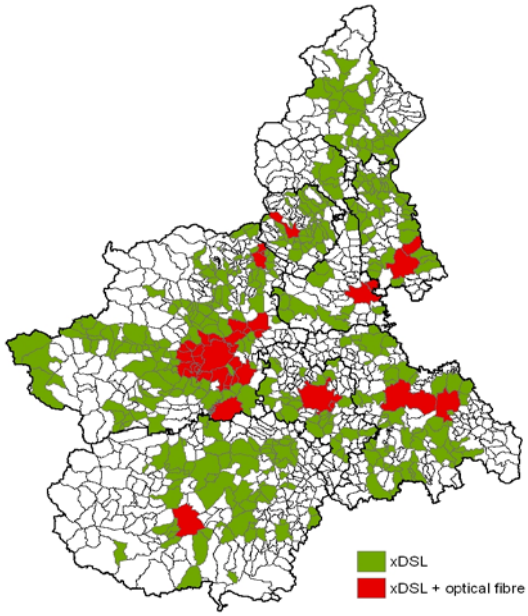

Figure 7. Map of broadband network coverage

While Figure 7 represents a good snapshot, it does not provide any insight in terms of the dynamics of the broadband diffusion over time. Therefore, we looked into two cumulative broadband diffusion curves for two different user groups: municipalities and general public. Figure 8 depicts the broadband diffusion in terms of percentage of municipalities covered by broadband from January 1999 to January 2005, and Figure 9 depicts the percentage of population reached by broadband for the same time period. These dynamics are of special interest since they allow understanding both the broadband diffusion patterns (market driven versus technology push) and the point reached on the "S" shaped diffusion curve.

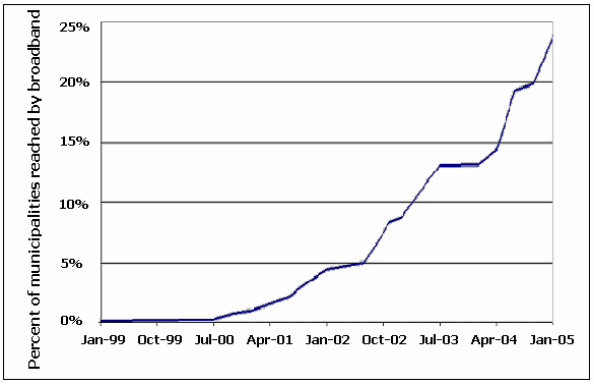

Figure 8. Percentage of municipalities covered by broadband, January 1999 - January 2005

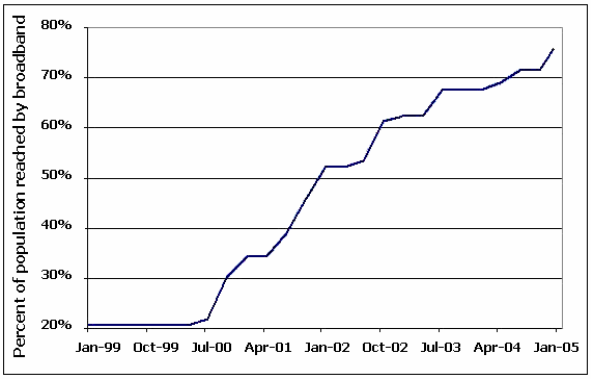

Figure 9. Percentage of population reached by broadband, January 1999 - January 2005

First, it is important to note that periods of large network infrastructure expansion were followed by periods of stagnation. Even if the curve has not yet reached the saturation point, there is a progressive slowdown in the percentage of citizens reached by broadband, which is explained by the low population density of the municipalities that are still not covered by broadband. Both curves shown on Figure 8 and 9 suggest that the impact of technological push has been much stronger compared to broadband demand pull. This assumption is supported by the low adoption levels present among residential users (on average only 24% of households have adopted broadband out of 70% potential users).

Survival analysis was used to investigate some of the factors that characterized the broadband diffusion in Piedmont: the coverage of the municipality by broadband services was set as the death event.

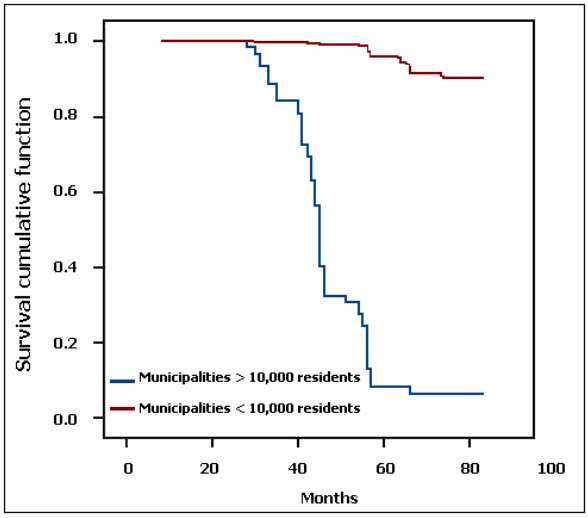

Figure 10. Survival curve of municipalities reached by broadband

The survival function (see Figure 10) shows a situation in which municipalities with less than 10,000 residents have been completely disregarded for a relatively long period of time. Only recently small municipalities have been considered by TLC carriers. Nevertheless, the broadband diffusion patterns among small municipalities appear to be far slower than those experienced by medium and large municipalities (i.e. municipalities with over 10,000 residents).

Figure 11 shows the hazard rate function for municipalities neighboring other municipalities that are covered by broadband infrastructure compared to those municipalities not neighboring other municipalities already reached by broadband.

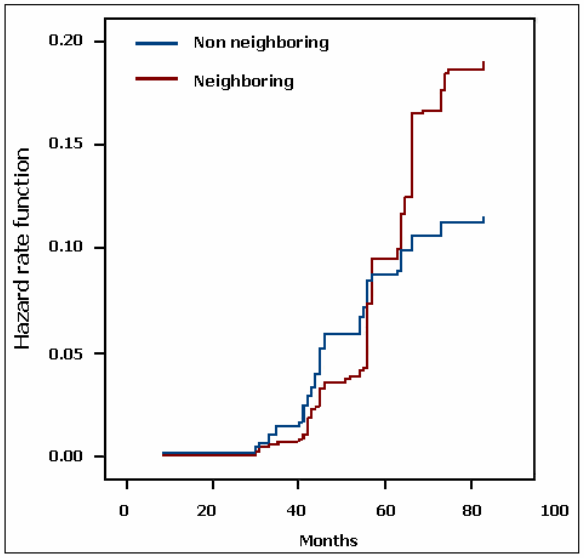

Figure 11. Hazard rate function by neighborhood

The hazard function rate suggests that once reached a critical mass in terms of municipalities covered, small municipalities in close physical proximity to municipalities already reached by broadband enjoy positive externalities. At the beginning of the diffusion process the hazard rate function did not seem to play a significant role, however, once reached a certain point, its' impact increased drastically. It is also interesting to note that the first sudden increase in the value of the hazard rate of neighboring municipalities roughly corresponds to the same point in time in which small municipalities started being considered by TLC carriers as shown in Figure 10. This reinforces the evidence towards the hypothesis of positive externalities.

Thus, as Lehr et al. noted, "The implication for policy makers is that a portfolio of broadband-related policy interventions that is reasonably balanced is more likely to lead to positive economic outcomes than a single-minded focus on availability" [12].

6. Conclusion

The analysis carried out in our study has confirmed the presence of a positive direct relationship between broadband availability and the implementation of e-Government services. Consequently, a widespread availability of broadband connections represents a prerequisite for creating a situation of fair opportunities in terms of access to online public services.

The study of the broadband diffusion process occurred in Piedmont over the last five years revealed a situation where only 24% of local public administrations are reached by a broadband network. The diffusion process was also characterized by technology push dynamics.

As per infrastructure diffusion determinants, municipality size emerged to be the main driver and municipalities with 10,000 residents seemed to be the discriminating threshold. As a result, all the municipalities below that threshold (about 90% of the total) are at risk of experiencing an e-Government supply divide. In fact, the presence of some spill-over effects due to the physical proximity to a covered municipality is not believed to be sufficient to stimulate a total broadband coverage of the territory. For this reason, alternative solutions need to be sought in order to make the coverage of smaller municipalities economically viable.

To overcome the issues identified both in terms of infrastructure coverage and service adoption the use of wireless technologies s seem to be a viable solution.

From a supply point of view, the combination of different technologies (i.e. Satellite-HiperLAN-Wi-Fi) may be used to reduce infrastructure costs and thus lower the brake even threshold in terms of potential users.

From a demand standpoint, instead the use of Wi-Fi solutions may be used to share bandwidth and subscription costs leading therefore to a reduction in the budget constraint.

Concluding, a comprehensive management policy on broadband diffusion, should account the interdependency present between demand and supply as well as the relationship with complementary activities such as eGovernment and eBusiness.

Bibliography

[1]. "The New National Dream: Networking the Nation for Broadband Access Report of the National Broadband Task Force," Canadian National Broadband Task Force.

[2]. Annis, R., McNiven, J., and Curri, M. "Industry Canada Broadband Economic Impact Study," Rural Development Institute, Brandon University, Brandon, Manitoba, pp. 1-51.

[3]. Bauer, J.M., Gai, P., Kim, J., Muth, T.A., and Wildman, S.S. "Broadband: Benefits and Policy Challenges," The James H. and Mary B. Quello Center for Telecommunication Management and Law, Michigan State University, East Lansing, MI pp. 1-103.

[4]. Brynjolfsson, E., Hitt, L.M., and Yang, S. "Intangible Assets: Computers and Organizational Capital," in: *Brookings Papers on Economic Activity*, 2002, pp. 137-199.

[5]. Clark, D., Gillett, S., Lehr, W., Sirbu, M., and Fountain, J. "Local Government Stimulation of Broadband: Effectiveness, E-Government, and Economic Development," MIT press 2002.

[6]. Crandall, R.W., and Jackson, C.L. "The $500 Billion Opportunity: The Potential Economic Benefit of Widespread Diffusion of Broadband Internet Access," Criterion Economics, L.L.C., pp. 1-72.

[7]. Flamm, K. "The Role of Economics, Demographics, and State Policy in Broadband Competition: An Exploratory Study," in: *32nd Telecommunications Policy and Research Conference*, Arlington, VA, 2004.

[8]. Flamm, K., and Chaudhuri, A. "An Analysis of the Determinants of Broadband Access," in: *33rd Telecommunications Policy and Research Conference*, Arlington, VA, 2005.

[9]. Gillett, S., Lehr, W., and Osorio, C. "Local Government Broadband Initiatives," in: *31st Research Conference on Communication, Information and Internet Policy (TPRC)*, Arlington, VA, 2003, pp. 537-558.

[10]. Grubesic, T.H. "The Geodemographics Correlates of Broadband Access and Availability in the United States," *Telematics and Information* (21:4) 2004, pp 335-358.

[11]. Lehr, W., and Lichtenberg, F. "Computer Use and Productivity Growth in Federal Government Agencies, 1987 to 1992," *Journal of Industrial Economics* (46:2) 1998, pp 257-279.

[12]. Lehr, W.H., Osorio, C.A., Gillett, S.E., and Sirbu, M.A. "Measuring Broadband's Economic Impact," in: *33rd Research Conference on Communication, Information, and Internet Policy (TPRC)*, Arlington, VA, 2005.

[13]. Varian, H.R. "The Demand for Bandwidth: Evidence from the INDEX Project," University of California, Berkeley, Berkeley, CA, pp. 1-19.