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The Impact of the Broadband Internet on Employment

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6.1 Introduction

The topic of the impact of the broadband Internet on employment has been present in the public policy arena quite regularly in the past years. Unfortunately, such an important debate has been approached with little formalization of the research of impact and understanding of the evidence. Before even tackling the prescriptive side of the policy debate, researchers appear to be aligned in two camps: The Internet contributes to the creation of jobs, and, on the opposite side, the Internet is the source of job destruction. Unfortunately, in many cases, research is being conducted hypothetically (e.g., what kind of jobs are susceptible to be eliminated as a result of digitization?[1]) without looking at the evidence of what has occurred since the Internet has become widely adopted by consumers and enterprises. This chapter summarizes the results of investigations conducted by this author and other researchers with regard to impact of broadband on employment.[2]

This chapter argues that, based on the evidence, the response to the question of impact of broadband on employment is: it depends. In fact, it will be shown that broadband contributes to the creation of jobs in certain industries and geographies, while also being a key factor in capital-labor substitution under certain conditions. As is always the case, this kind of answer does

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not satisfy pundits or ideologues. However, in the end, if policy makers are oriented toward making good decisions, they need to have a solid, unbiased understanding of the evidence.

6.2 What Does Our Research Tell Us About Employment Effects of Broadband?

Broadband can have a positive effect on job creation under certain circumstances. To begin with, broadband deployment programs tend to create jobs under attractive multipliers on a short-term basis. We tend to call this the "construction effect", which has been put in place with good results as a countercyclical measure. Second, deployment of broadband in emerging countries enables these nations to attract employment (especially low paid business process outsourcing jobs) from industrialized economies. It could be argued, however, that this represents a zero-sum game since an emerging country gain is an industrialized nation loss.

A third job creation effect of broadband has been identified in advanced economies. It refers to the emergence of broadband-enabled businesses that were previously nonexistent, such as Internet search and advertising and electronic commerce. Finally, even within industries that predate the Internet, broadband has generated spill-overs with regards to job creation. To clarify, broadband enables business to redeploy functions in order to achieve better economics: This could lead to the creation of employment in certain regions in order to benefit from the availability of wider labor pools or lower factor costs. We acknowledge that this is again a case of zero-sum (a job loss in a metropolitan area represents a gain in a suburban or rural zone). However, we have detected a fifth effect, which we could refer to as the market reach. In this case, firms can rely on broadband to deploy distribution channels in otherwise unserved remote geographies. We do not refer here to electronic commerce channels since these firms do not need a physical presence to reach remote areas but consider industries that still require some brick and mortar (and consequently employees) to deliver a certain service. An example of this effect can be found in the health-care sector: broadband represents an enabling technology allowing hospitals to deploy "satellite" clinics in remote areas charged with delivery health-care services while benefitting from accessing technical and clerical support from a central facility. We have so far outlined job creation effects related to broadband technology. Let's now move job destruction cases.

First and foremost, we recognize the other side of the zero-sum game of low paid jobs in industrialized countries being outsourced to emerging

nations to exploit lower factor costs. Second, we have found both in industrialized and emerging countries strong capital/labor substitution effects in labor-intensive sectors. A case in point is the tourism industry, where broadband has contributed to reduce employment across the board. Third, one should not underestimate job losses in rural geographies resulting from broadband adoption. While job losses driven by productivity enhancements in metropolitan areas can be compensated by innovation-led new business models or natural expansion, rural settings lack this mechanism.

As it can be seen, the answer to the job creation/destruction question is: It depends on the sector, geography, and overall stage of economic development. We will now move to detail the empirical evidence in support of each of these effects.

6.3 The "Construction" Effect

There are three types of job creation effects resulting from broadband network construction. The first, most straightforward one comprises employment growth generated in the course of deployment of network infrastructure. Jobs in this area typically entail telecommunications technicians, construction workers and civil and radio frequency engineers. The second job creation effect captures indirect jobs triggered by network construction. It entails employment generated by indirect spending or businesses buying and selling to each other in support of direct network rollout. Jobs created through this effect include metal products and electrical equipment workers, as well as professional services. Finally, the third job creation effect resulting from network deployment comprises jobs induced by household spending based on the income earned from the direct and indirect effects. In this case, we are referring to employment in consumer durables, retail trade, and consumer services.

Four national studies have estimated the impact of network construction on job creation: Crandall et al. (2003), Atkinson et al. (2009), Liebenau et al. (2009), and Katz et al. (2008). They all relied on input–output matrices and assumed a given amount of capital investment: USD 63 billion (needed to reach ubiquitous broadband service in the United States) for Crandall et al. (2003), CHF 13 billion for Katz et al. (2008) (to build a national multi-fiber network for Switzerland), USD 10 billion for Atkinson et al. (2009) (as a US broadband stimulus) and USD 7.5 billion for Liebenau et al. (2009) (needed to complete broadband deployment in the United Kingdom) (see Table 6.1).

Table 6.1 Broadband impact on job creation (*Sources* Katz, R., and S. Suter (2009), Estimating the Economic Impact of the US Broadband Stimulus Plan, Columbia Institute for Tele-Information Working Paper; Katz, R., P. Zenhäusern, S. Suter, P. Mahler, and S. Vaterlaus (2008), *Economic Modeling of the Investment in FTTH in Switzerland*, unpublished report; Libenau, J., and R. Atkinson (2009), *The UK's Digital Road to Recovery*. LSE and ITIF; Australian government. Katz, R., Vaterlaus, P. Zenhäusern, S. Suter, and P. Mahler (2009), *The Impact of Broadband on Jobs and the German Economy*; Columbia Institute for Tele-Information Working Paper)

Country	Authors—institution[a]	Objective	Results
United States	Crandall et al. (2003)—Brookings Institution	Estimate the employment impact of broadband deployment aimed at increasing household adoption from 60 to 95%, requiring an investment of USD 63.6 billion	• Creation of 140,000 jobs per year over ten years • Total jobs: 1.2 million (including 546,000 for construction and 665,000 indirect)
	Atkinson et al. (2009)—ITIF	Estimate the impact of a USD 10 billion investment in broadband deployment	• Total jobs: 180,000 jobs-year (including 64,000 direct and 116,000 indirect and induced)
Switzerland	Katz et al. (2008)—CITI	Estimate the impact of deploying a national broadband network requiring an investment of CHF 13 billion	• Total jobs: 114,000 over four years (including 83,000 direct and 31,000 indirect)
United Kingdom	Liebenau et al. (2009)—LSE	Estimate the impact of investing USD 7.5 billion to achieve the target of the *"Digital Britain"* Plan	• Total jobs: 211,000 jobs-year (including 76,500 direct and 134,500 indirect and induced)
Australia	Australian government	Estimate the impact of investing USD 31,340 million to deploy high speed broadband	• Total jobs: ~ 200,000 jobs-year

[a] *ITIF* Information Technology and Innovation Foundation, *CITI* Columbia Institute for Tele-Information, *LSE* London School of Economics

Since these studies were triggered by the consideration of countercyclical plans devised to face the 2008 economic crisis, they tended to focus primarily on gauging the ability of broadband to create jobs. All studies calculated multipliers, which measure the total employment change throughout the economy resulting from the deployment of a broadband network. Multipliers are of two types: Type I multipliers measure the direct and indirect effects (direct plus indirect divided by the direct effect), while type II multipliers measure type I effects plus induced effects (direct plus indirect plus induced divided by the direct effect). Cognizant that multipliers from one geographic region cannot be applied to another, it is useful to observe the summary results for the multipliers of the four input–output studies (see Table 6.2).

According to the sector interrelationships as depicted above, European economies would appear to have lower indirect effects than the United States. Furthermore, the disaggregation of effects also indicates that a relatively important job creation induced effect occurs as a result of household spending based on the income earned from direct and indirect jobs.[3]

While input–output tables are a reliable tool for predicting investment impact, two words of caution need to be given. First, input–output tables are static models reflecting the interrelationship between economic sectors at a certain point in time. Since those interactions may change over time, the matrices could lead us to overestimate or underestimate the impact of

Table 6.2 Employment multiplier effects of studies relying on input–output analysis (*Source* Katz, R., and S. Suter (2009), Estimating the Economic Impact of the US Broadband Stimulus Plan, Columbia Institute for Tele-Information Working Paper; Katz, R., P. Zenhäusern, S. Suter, P. Mahler, and S. Vaterlaus (2008), *Economic Modeling of the Investment in FTTH in Switzerland*, unpublished report; Liebenau, J., Atkinson, R. (2009). *The UK's Digital Road to Recovery*. LSE and ITIF; Australian government. Katz, R., S. Vaterlaus, P. Zenhäusern, S. Suter, and P. Mahler (2009), *The Impact of Broadband on Jobs and the German Economy*; Columbia Institute for Tele-Information Working Paper)

Country	Studies	Type I	Type II
United States	Crandall et al. (2003)	N.A.	2.17
	Atkinson et al. (2009)	N.A.	3.60
	Katz et al. (2009)	1.83	3.42
Switzerland	Katz et al. (2008)	1.38	N.A.
United Kingdom	Liebenau et al. (2009)	N.A.	2.76
Germany	Katz et al. (2010)	1.45	1.92

N.A. Not Available

Note Crandall et al. (2003) and Atkinson et al. (2009) do not differentiate between indirect and induced effects, therefore we cannot calculate Type I multipliers; Katz et al. (2008) did not calculate Type II multiplier because induced effects were not estimated

network construction. For example, if the electronic equipment industry is outsourcing jobs overseas at a fast pace, the employment impact of broadband deployment will diminish over time and part of the countercyclical investment will "leak" overseas. Second, it is critical to break down employment effects at the three levels estimated by the input–output table in order to gauge the true direct impact of broadband deployment. Having said that, all these effects have been codified and therefore, with the caveat of the static nature of input–output tables, we believe that the results were quite reliable.

6.4 Job Creation Resulting from Broadband Spillovers

Beyond the employment and output impact of network construction, researchers have also studied the impact of network externalities on employment variously categorized as "innovation", or "network effects".[4] The study of network externalities resulting from broadband penetration has led to the identification of numerous effects:

- New and innovative applications and services, such as telemedicine, Internet search, e-commerce, online education, and social networking[5]
- New forms of commerce and financial intermediation[6]
- Mass customization of products[7]
- Marketing of excess inventories and optimization of supply chains[8]
- Business revenue growth[9]
- Growth in service industries[10]

The evidence regarding broadband employment externalities also appears to be quite conclusive (see Table 6.3).

The spillover impact of broadband on employment creation appears to be positive. However, as the evidence indicates, the impact on employment growth varies widely, from 0.2 to 5.32% for every increase in 1% of penetration. There are several explanations for this variance. As Crandall indicated, the overestimation of employment creation in his study is due to employment and migratory trends, which existed at the time and biased the sample data. In the case of Gillett et al. (2006), researchers should be careful about analyzing local effects because zip codes are small enough areas that cross-zip code commuting might throw off estimates on the effect of broadband. For example, increased wages from broadband adoption in one zip code would probably raise rent levels in neighboring zip codes prompting some migration effects. Finally, the wide range of effects in the case of Shideler et al. (2007)

Table 6.3 Research results of broadband impact on employment in the United States (*Source* Author)

Study	Data	Effect
Crandall et al. (2007)	48 US states for the period 2003–2005	For every 1% point increase in broadband penetration in a state, employment is projected to increase by 0.2–0.3% per year "assuming the economy is not already at 'full employment'"
Thompson and Garbacz (2008)	46 US states during the period 2001–2005	Positive employment generation effect varying by industry
Gillett et al. (2006)	US zip codes for the period 1999–2002	Broadband availability increases employment by 1.5%
Shideler et al. (2007)	Disaggregated county data for state of Kentucky for 2003–2004	An increase in broadband penetration of 1% contributes to total employment growth ranging from 0.14 to 5.32% depending on the industry

is explained by the divergent effects among industry sectors. We will explore this particular effect in turn.

6.5 Differential Employment Impact by Industry Sector

As with output, the spillover employment effects of broadband are not uniform across sectors. Two studies have identified differential levels of impact. According to Crandall et al. (2007), the job creation impact of broadband tends to be concentrated in service industries (e.g., financial services, education, health care, etc.) although the authors also identified a positive effect in manufacturing (see Table 6.4).

In another study, Shideler et al. (2007) found that, for the state of Kentucky, county employment was positively related to broadband adoption in the following sectors (see Table 6.5).

The only sector where a negative relationship was found with the deployment of broadband (0.34–39.68%) was the accommodations and food services industry. This may result from a particularly strong capital/labor

Table 6.4 Coefficient of broadband penetration in employment growth by sector (with significance at the 5% and 1% confidence level) (*Source* Crandall et al. 2007)

Sector	Employment 2005–4		Employment 2005–3	
	Coefficient	*T*-statistic	Coefficient	*T*-statistic
Manufacturing	0.371	2.46	0.789	2.59
Educational services	2.741	2.73	4.054	3.25
Health care	3.369	2.50	0.656	2.51
Accommodation and food services	0.284	2.12	N.A.	
Finance and insurance	N.A.		1.043	3.09

N.A. Statistically not significant

Table 6.5 Kentucky: Differential impact of broadband by industry sector (*Source* Shideler et al. 2007)

Sector	95% Confidence interval (%)
Aggregate	0.14–5.32
Construction	0.62–21.76
Information	25.27–87.07
Administrative	23.74–84.56

substitution process, whereby productivity gains from broadband adoption yields reduced employment. Crandall et al. (2007) also found a negative relationship for the Arts, Entertainment & Recreation sector, although it was not statistically significant. Similarly, Thompson and Garbacz (2008) concluded that, for certain industries, "there may be a substitution effect between broadband and employment".[11] It should therefore be considered that the productivity impact of broadband can cause capital-labor substitution and may result in a net reduction in employment.

In summary, research pinpoints different employment effects by industry sector. Broadband may simultaneously cause labor creation triggered by innovation in services and a productivity effect in labor-intensive sectors. In light of these effects, given that the sector composition varies by regional economies, the deployment of broadband should not have a uniform impact across a national territory.

6.6 Differential Employment Impact by Region

In two studies conducted by this author, it was found that, as expected, employment impact of broadband technology varies by region of a country.

In study conducted with German data by Länder (counties) split between high broadband penetrated and low broadband penetrated counties, it was found that employment impact varied significantly by region (see Table 6.6).

In high broadband penetrated counties the short-term impact of the technology is very high both on GDP and employment, but it declines over time. This "supply shock" is believed to occur because the economy can immediately utilize the new deployed technology. Furthermore, the fact that employment and GDP grow in parallel indicates that broadband has a significant impact on innovation and business growth, thereby overcoming any employment reduction resulting from productivity effects.

On the other hand, in counties with low broadband penetration the impact on GDP of broadband penetration is lower than in high-penetrated areas in the short term, but "catches up" to comparable levels over time. The impact of broadband on employment is slightly negative in the initial years.

Table 6.6 Germany: Comparative effects between high broadband and low broadband counties (*Source* Katz et al. 2010)

	Total	Low penetration	High penetration
Growth of GDP[a]			
GDP per Capita 2000 (*1,000,000)	0.0261	0.0627	0.0185
	(0.041)	(0.121)	(0.050)
Population growth (2000–2006)	0.6318***	0.5311***	0.7731***
	(0.075)	(0.102)	(0.116)
Broadband penetration growth (2002–2003)	0.0255***	0.0238***	0.0256***
	(0.002)	(0.005)	(0.003)
R^2 adjusted	0.6317	0.6321	0.6305
Number of observations	424	210	214
Growth of Employment[b]			
GDP per Capita 2000 (*1,000,000)	0.0362*	–0.0066	0.0030
	(0.024)	(0.072)	(0.029)
Population growth (2000–2006)	1.0481***	1.1265***	0.9072***
	(0.044)	(0.061)	(0.066)
Broadband penetration growth (2002–2003)	0.0020*	0.0027	0.0061***
	(0.001)	(0.003)	(0.002)
R^2 adjusted	0.6065	0.6597	0.5557
Number of observations	424	210	214

[a]Dependent Variable: Growth of GDP between 2003 and 2006.
G_GDP (03–06) = β1 × GDP_Capita_2000 + β2 × G_POP (00–06) + β3 × G_BBPEN (02–03).
[b]Dependent Variable: Growth of Employment between 2003 and 2006.
G_EMP (03–06) = β1 × GDP_Capita_2000 + β2 × G_POP (00–06) + β3 × G_BBPEN (02–03).
***, ** and * indicate a significance level of 5%, 10% and 15%. Standard errors in parenthesis

This indicates that the impact of broadband in low penetration areas is more complex than in the high penetration areas. The increase in broadband penetration in low penetrated areas takes longer to result in economic growth because these economies require a longer period of time to develop and fully utilize the technology. However, after three years the level of impact of broadband in low penetrated regions is as high as in the more developed areas. Negative initial employment growth appears to indicate that the productivity increase resulting from the introduction of new technology is the most important effect to begin with. However, once the economy develops, the other network effects (innovation and value chain recomposition) start to play a more important role, resulting in job creation.[12] Therefore broadband deployment in low-penetrated areas will likely generate high stable economic growth ("catch up" effect) combined capital/labor substitution, which initially limits employment growth ("productivity" effect). Figure 6.1 presents in conceptual fashion a comparison of impact in both regions.

A similar differentiated effect was found by this author in a study of broadband impact in the state of Kentucky. Similarly to Kandilow and Renkow (2010) results regarding broadband loans in rural areas, it was found that the impact of broadband availability is dependent upon the area of deployment. Katz et al. (2012) have found that while though broadband availability impacts rural as well as metropolitan counties, the effect appears to be area-specific (see Table 6.7).

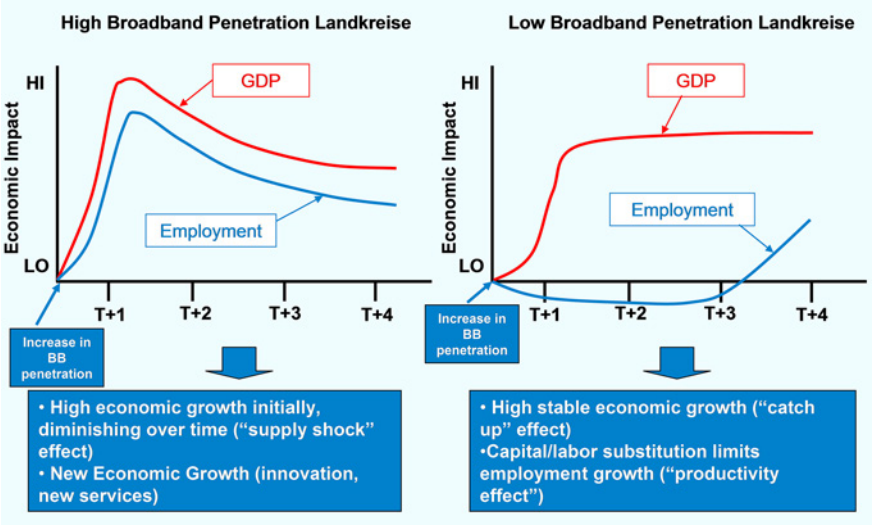

Fig. 6.1 Conceptual view of comparative broadband regional effects (Only effects up to t + 3 are estimated.) (*Source* Adapted from Katz et al. 2010)

Table 6.7 Kentucky: Impact of a 1% increase in broadband availability on employment and median income (*Source* Data compiled from Connect Kentucky databases, and ESRI Business Analyst Sourcebook for County demographics; Katz et al. 2012)

	Impact on median income	Impact on employment
Metropolitan counties	0.0968*	0.0301
Rural counties adjacent to metro counties	0.0704*	–0.1953*
Rural counties isolated from metro counties	0.0800*	

*Significant at the 1% level

The model results show that the impact of broadband on median income is statistically significant for each of the three types of counties. They also suggest that this impact is the highest for metro counties, followed by isolated rural counties, and lastly rural counties that are adjacent to metro counties. On the other hand, the impact on unemployment is only significant for rural counties.[13] This is a reasonable result in light of the merging of labor markets. In this context, it is to be expected that broadband will have the smallest impact on metro counties. These counties have the lion's share of establishments and employment opportunities so increasing the size of the labor market should have only marginal if any positive effects. However, broadband may extend labor markets to rural areas, for example, by enabling telecommuting. Of these rural counties, the primary beneficiaries are rural counties that are adjacent to metro areas because the labor force is more technologically skilled (in accordance with the industries that are present). We expect that isolated rural areas will also benefit, but at a lower rate.

Theoretically, we also expect that firms in the services industries can reap greater productivity gains from broadband (see below for the results on sector-specific broadband effects). Hence it is expected that metro counties, which account for the vast majority of such firms, will experience the largest impact on income. This indicates that the employment opportunities created by broadband in these areas are far more lucrative than the median job. Though the portion of the population that is technologically skilled in these areas may be small, it is likely that the incremental benefits of broadband for this population are quite high. However, it was not possible to identify a statistically significant result for metro counties.

The impact of broadband penetration was found to be statistically significant on the growth in employment in the financial services and insurance, wholesale trade, and health sectors (see Table 6.8).

The results of the sector impact models are quite illuminating in terms of determining which industries are most benefited by rural broadband.

Table 6.8 Kentucky: Impact of broadband penetration by 1% on industrial sector employment (*Source* Data compiled from US Census Bureau, Connect Kentucky databases, and ESRI Business Analyst Sourcebook for County demographics; Katz et al. 2012)

Industry sector	All counties	Rural counties
Financial services and insurance	0.678**	0.517***
Wholesale trade	0.846*	0.836*
Health services	0.126*	0.122**
Construction	Not significant	Not significant
Retail trade	Not significant	Not significant
Accommodation	Not significant	Not significant

*Significant at 1% level, **Significant at 5% level, ***Significant at 10% level

While effects are statistically significant in finance, wholesale trade, and health services, the impact is largest in the trade sector, reflecting the value of broadband as an enabler of relocation of warehouses and distribution centers to areas outside the metropolitan counties. Furthermore, while employment is also positively impacted by broadband in finance, its contribution diminishes in rural environments reflecting the difficulty of locating financial back offices in rural areas, primarily due to limits in labor pool availability. On the other hand, the decline in impact of health services for rural areas is not that important revealing both the existence of demand in rural areas and the value of broadband in enabling the redeployment of health facilities.

6.7 Conclusion

To conclude, the evidence regarding employment impact of broadband Internet underlines the danger of reaching uniform deterministic answers. Deployment of broadband networks has a short-term Keynesian effect, while spillover impact requires a much longer time frame to materialize. Moreover, externalities tend to vary substantially by geography and industrial sector. One can assume that similar conclusions could extend to the impact of job creation across the digital ecosystem. For example, research indicates that, direct job creation effect of digital platforms appears to be fairly limited,[14] while indirect employment created as a result of new firm creation is fairly large.[15]

This evidence points out to the need to develop public policies that promote positive effects in terms of job creation, while mitigating the negative ones. For example, nations undergoing important broadband network deployment efforts should consider implementing conventional rural

development programs aimed at reducing "hollowing out" effects. In the case of emerging nations, it would be convenient to centralize digital policy development and implementation in order to control for potential job losses in certain sectors and geographies.

Notes

1. See Frey, C., and M. Osborne (2013), *The Future of Employment: How Susceptible Are Jobs to Computerization*. Oxford University Martin School.
2. The difference between the causal factor (broadband or Internet) is quite important. While broadband is the telecommunication technology required to access the web, it also contributes to the communication among individuals, enterprises, and government agencies.
3. It is assumed that induced effects should be counted since in 2008, no full employment conditions existed.
4. Atkinson et al. (2009).
5. Op. cit.
6. Op. cit.
7. Op. cit.
8. Op. cit.
9. Varian et al. (2002), Gillett et al. (2006).
10. Crandall et al. (2007).
11. This effect was also mentioned by Gillett et al. (2006).
12. This said, the available data sets do not enable us to test this last point at this time.
13. The models run for employment impact on rural-adjacent and rural-isolated yielded nonsignificant results.
14. By 2014, Google, Facebook, Skype, Twitter, LinkedIn, and Netflix accounted for a total headcount of 68,885 (*Source* Annual reports).
15. In Latin America alone, the video game industry created 120,000 jobs (*Source* Katz 2015).

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