

Broadband stimulus and the economy

Dr. Raúl L. Katz
Adjunct Professor, Division of Finance
and Economics

Director, Business Strategy Research
Columbia Institute of Tele-information

*CITI's Annual Conference on the State of Telecom:
National Next-Generation Broadband Plans
October 23, 2009
Columbia University, New York*

What is the economic impact of broadband stimulus plans?

WHAT WE KNOW	WHAT WE ARE STARTING TO UNDERSTAND	WHAT WE KNOW WE DON'T KNOW YET
<ul style="list-style-type: none">•The construction of broadband network has important direct and indirect employment effects•The induced effects of network construction magnify the total impact of network deployment•Revenue "leakage" varies by country•Once broadband is deployed positive externalities have also significant economic impact	<ul style="list-style-type: none">•How many jobs can be lost as a result of broadband induced capital-labor substitution?•What is the economic impact in advanced industrialized vs. rural regions?	<ul style="list-style-type: none">•What is the relationship between faster broadband speeds and economic output and employment?•Is there a broadband saturation point beyond which network externalities tend to substantially diminish?

Agenda

- What we know
- What we are starting to understand
- What we know we don't know yet
- Policy and research implications

Three types of network construction effects exist

EFFECT	DESCRIPTION	EMPLOYMENT EXAMPLES
Direct jobs and output	<ul style="list-style-type: none">• Employment and economic production generated in the short term in the course of deployment of network facilities	<ul style="list-style-type: none">• Telecommunications technicians• Construction workers• Civil and RF engineers
Indirect jobs and output	<ul style="list-style-type: none">• Employment and production generated by indirect spending (or businesses buying and selling to each other in support of direct spending)	<ul style="list-style-type: none">• Metal products workers• Electrical equipment workers• Professional Services

Network construction effects and multipliers are significant

NETWORK CONSTRUCTION EFFECTS OF BROADBAND

COUNTRY	STIMULUS INVESTMENT (USD billion)	NETWORK DEPLOYMENT JOBS ESTIMATE				MULTIPLIERS	
		DIRECT	INDIRECT	INDUCED	TOTAL	TYPE I (*)	TYPE II (**)
UNITED STATES	\$ 6,390	37,000	31,000	60,000	128,000	1.83	3.42
SWITZERLAND	~\$ 10,000	~80,000	~30,000	N.A.	~110,000	1.38	N.A.
GERMANY	\$ 47,660	281,000	126,000	135,000	542,000	1.45	1.94
UNITED KINGDOM	\$ 7,463	76,500	134,500	211,000	276,000	1.45	2.76
AUSTRALIA	\$ 31,340				~200,000		

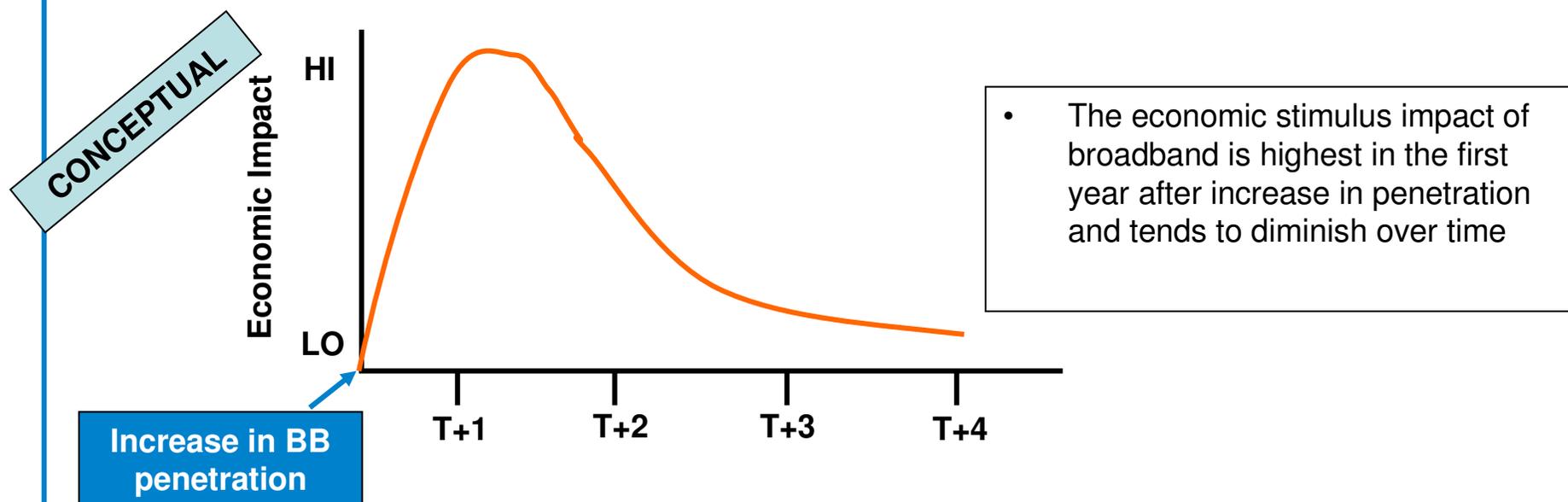
Sources: Katz, R. and Suter, S. (2009). *Estimating the economic impact of the US broadband stimulus plan*, Columbia Institute for Tele-Information working paper; Katz, R., Zenhäusern, P., Mahler and Vaterlaus (2008). *Economic Modelling of the Investment in FTTH in Switzerland*, unpublished report; Libenau, 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

However, the externalities derived from broadband are significantly higher

EFFECT	DESCRIPTION	EMPLOYMENT EXAMPLES
Productivity	<ul style="list-style-type: none">Improvement of productivity as a result of the adoption of more efficient business processes enabled by broadband	<ul style="list-style-type: none">Marketing of excess inventoriesOptimization of supply chains
Innovation	<ul style="list-style-type: none">Acceleration of innovation resulting from the introduction of new broadband-enabled applications and services	<ul style="list-style-type: none">New applications and services (telemedicine, Internet search, e-commerce, online education, VOD and social networking)New forms of commerce and financial intermediation

Economic impact of broadband in terms of network externalities have been found to be significant

- Our analysis estimates the impact of increase in broadband penetration on rate of economic growth
 - Due to the effect of high broadband penetration growth in 2001, time intervals were calculated for three stages: 2000-1, 2001-2, 2002-3
 - In addition, GDP and employment data was adjusted through an Hodrick-Prescott filter to time series in order to normalize for trends and business cycle effects
- Aggregate results for the whole territory indicate that broadband penetration has a significant short-term effect on economic growth



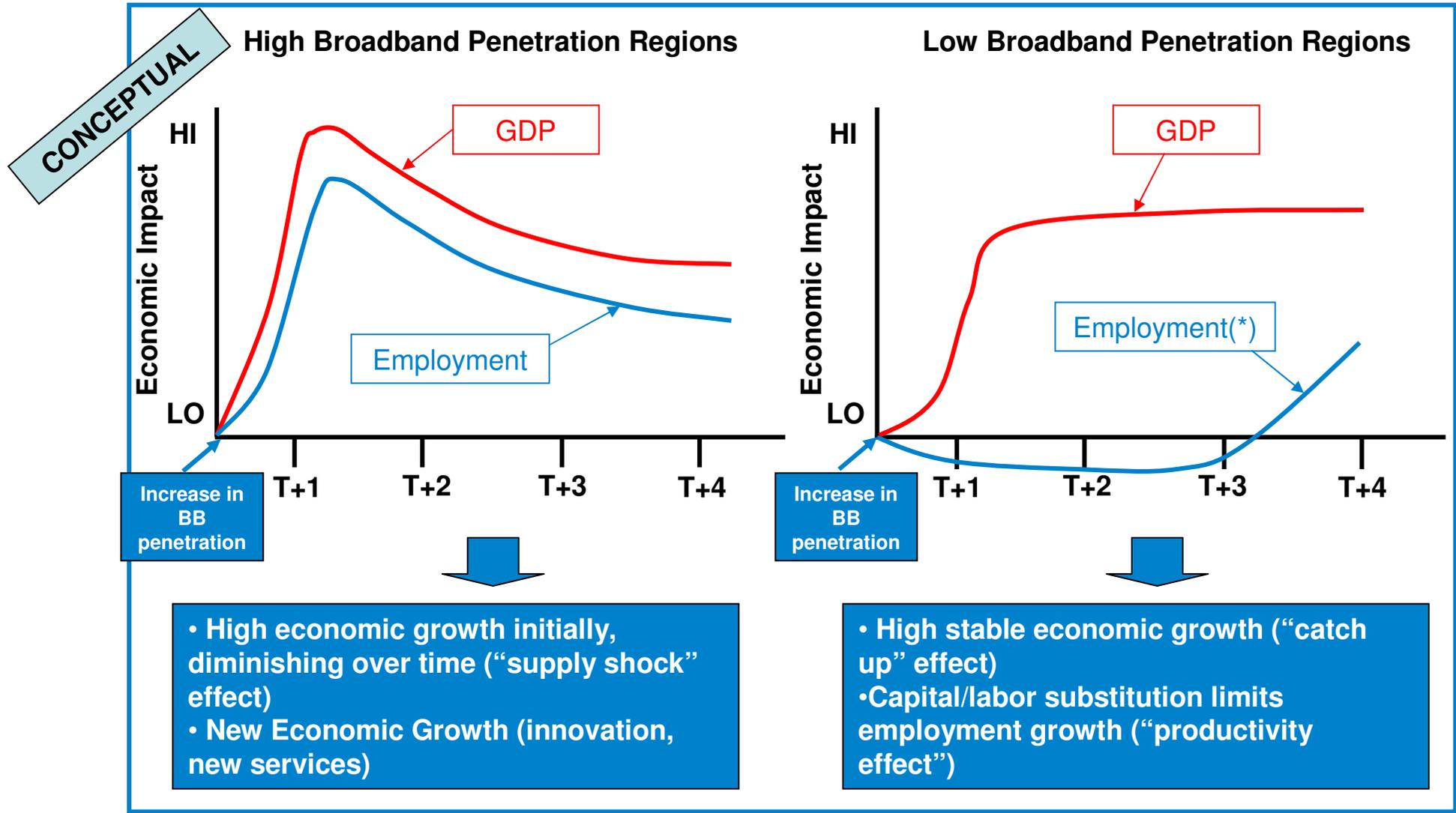
A growing body of econometric research conducted at the regional, national and international level confirm this finding

COUNTRY	STUDY	DATA	EFFECT
Germany	•Katz et al. (2009)	2000-2006 for Landkreise	An incremental penetration of broadband of 1% yields 0.026% incremental GDP growth
United States	•Lehr et al. (2005)	1998-2002 for US postal codes	Availability of broadband at the community level added over 1% to employment growth and 0.5% growth of businesses
	•Crandall et al. (2007)	For 48 US states	For every one percentage point increase in broadband penetration in a state, employment is projected to increase by 0.2 to 0.3 percent a year (...) assuming the economy is not already at "full employment"

Agenda

- What we know
- What we are starting to understand
- What we know we don't know yet
- Policy and research implications

We are generating evidence that the economic impact of broadband deployment varies by region

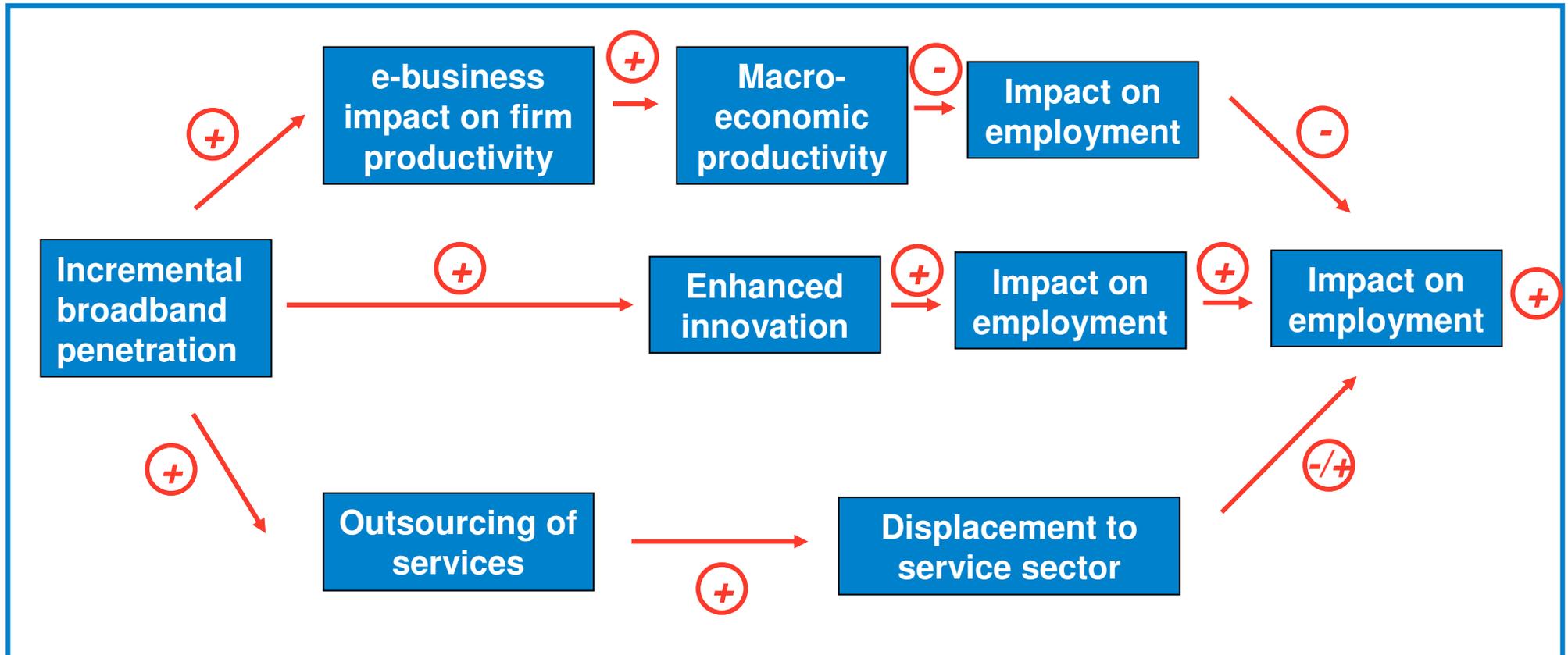


(*) Results are at a low significance level

Emerging evidence of differential impact of broadband by region or industry

COUNTRY	STUDY	DATA	EFFECT
Germany	•Katz et al. (2009)	2000-2006 for Landkreise	An increase of 1% in broadband penetration yields an incremental annual GDP growth rate of 0.61 percentage points for low penetrated Landkreise and 0.64 percentage points for high penetrated Landkreise
United States	•Lehr et al. (2005)	1998-2002 for US postal codes	The relation between broadband penetration and employment is not linear because the technology is adopted within a state first by those who get the greatest benefit (while) late adopters within a state will realize a lesser benefit
	•Thomson et al	2000-2006 for 48	Pointed out to the potential existence of a

This is consistent with the three simultaneous impact of broadband on employment



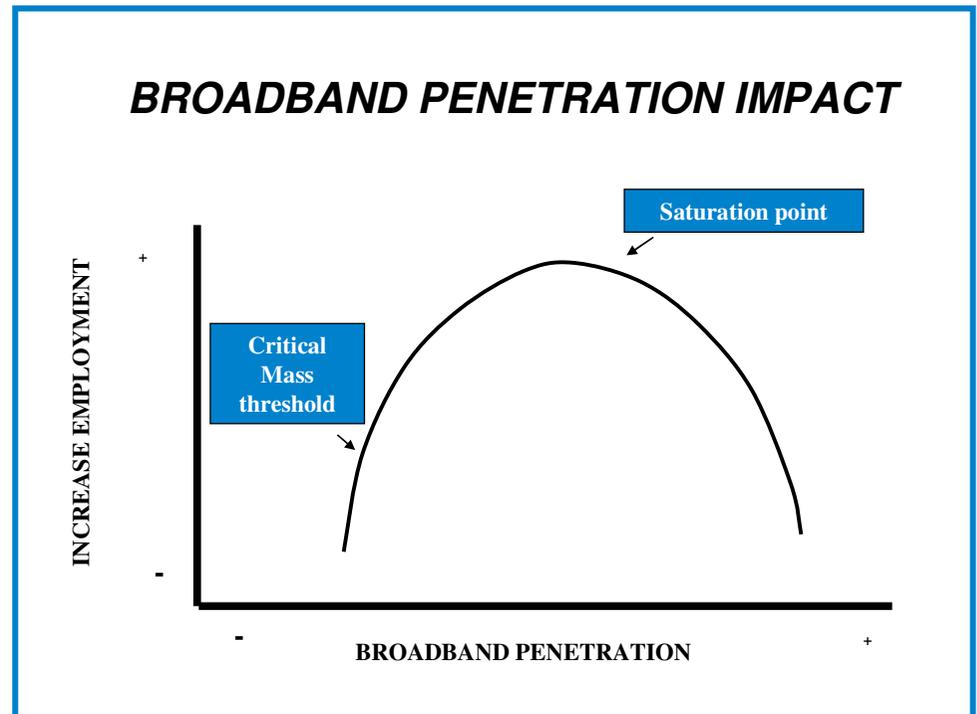
Note: This causality chain was adapted from a model originally developed by Fornefeld et al., 2008 in a report for the European Commission

Agenda

- What we know
- What we are starting to understand
- What we know we don't know yet
- Policy and research implications

Is there a saturation effect?

- Is there a linear relationship between broadband adoption and economic impact?
- Or are we in the presence of a more complex causality effect?
- Following the "critical mass", the impact of broadband on employment only becomes significant once the adoption of the platform achieves high penetration levels.
- At the other end of the diffusion process, a saturation point could exist beyond which we achieve decreasing returns
- Atkinson et al. (2009) also point out that network externalities do decline with the build out of networks and maturing technology over time.
- Hypothesis: the strength of the relationship is highest once the technology has achieved a certain critical mass but before it reaches saturation



Two pieces of evidence so far regarding potential saturation

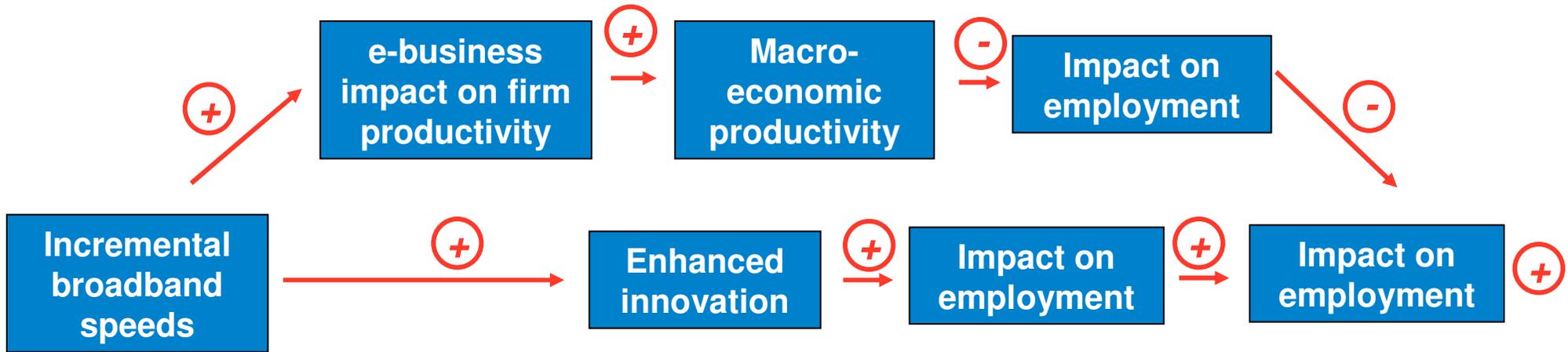
Kentucky study (Shideler et al., 2007): Yes

- Employment growth is highest around the mean level of broadband saturation at the county level, driven by the diminishing returns to scale of the infrastructure
- According to this, a critical amount of broadband infrastructure may be needed to sizably increase employment, but once a community is completely built out, additional broadband infrastructure will not further affect employment growth

German study (Katz et al, 2009): we do not know

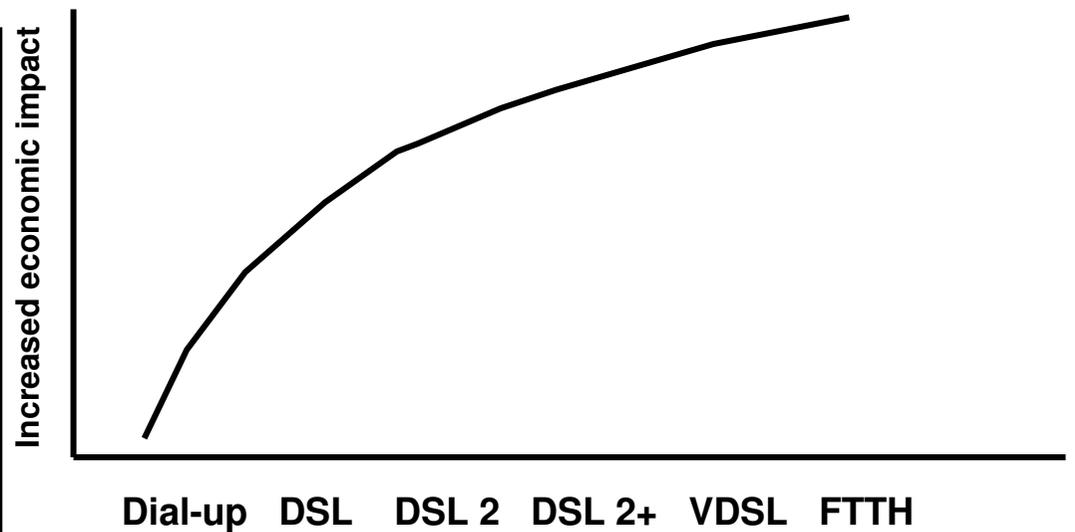
- Our estimates were all based on a linear model. This linear relationship was tested under different model specifications
 - Three-year aggregates
 - One-year impact
 - Different starting points in the series
- While we believe that some saturation effect might reduce the overall impact, our analysis was not able to identify a consistent trend
- Unfortunately, so far the low confidence on the coefficients prevents us from establishing a saturation effect

What is the relationship between faster speeds and improved QOS and economic output? We do not know



Application	Download speeds		
	500 Kbps	5 Mbps	50 Mbps
Google home page	0.3 sec	0.03 sec	0.003 sec
10 Mbs worksheet	150 sec	16 sec	1.6 sec
High quality videostreaming	Very low resolution	Medium resolution	High resolution

Source: SQW (2006)



Agenda

- What we know
- What we are starting to understand
- What we know we don't know yet
- Policy and research implications

Broadband deployment should be stimulated because of its economic impact

- Generate jobs and output as a result of the construction of networks
 - Estimates for network construction jobs are fairly robust and consistent with prior research
 - Output multiplier: every Euro invested in infrastructure, generates 0.90 Euros in domestic value added
- Promote innovation, and creation of new businesses once the networks are deployed
 - Accelerate development of core regions
 - Attract new industries, with employment potential
- However, differential impact across regions prompts the question of where to focus
 - It would appear that, in the short term, investment in advanced industrialized regions yields stronger impact
 - This needs to be balanced against a social policy oriented toward fostering digital inclusion
- Beyond social targets (e.g. universal broadband access >2Mbps), it might dangerous to set up penetration objectives because we do not know yet what is optimal
- It is imperative to launch studies to assess incremental economic impact of ultrabroadband in countries with advanced deployment

APPENDIX

Results of the regression analysis at the national level indicate high significance regarding the economic growth effect

BROADBAND AS A DRIVER OF GDP

Dependent Variable: Growth of GDP between 2003 and 2006
 $G_GDP(03-06) = \beta_1 * GDP_Capita_2000 + \beta_2 * G_POP(00-06) + \beta_3 * G_BBPEN(02-03)$

	Total
GDP per Capita 2000 (* 1'000'000)	0.0261 (0.041)
Population growth (2000 - 2006)	0.6318 *** (0.075)
Broadband penetration growth (2002 - 2003)	0.0255 *** (0.002)
R ² adjusted	0.6317
Number of Observations	424

Note: ***, ** and * indicate a significance level of 1%, 10% and 15%.

Standard errors in parentheses.

$$\Delta GDP_{t+1} = f((GDP/Pop)_{2000}, \Delta Pop_{2000-06}, \Delta BBPen_t)$$

$$\Delta GDP_{t+2} = f((GDP/Pop)_{2000}, \Delta Pop_{2000-06}, \Delta BBPen_t)$$

$$\Delta GDP_{t+3} = f((GDP/Pop)_{2000}, \Delta Pop_{2000-06}, \Delta BBPen_t)$$

$$\Delta GDP_{02-03} = 4.03e-07 * (GDP/Pop)_{2000} + 0.427 * \Delta Pop_{2000-06} + 0.0027 * \Delta BBPen_{2001-02}$$

$$\Delta GDP_{03-04} = 3.89e-07 * (GDP/Pop)_{2000} + 0.409 * \Delta Pop_{2000-06} + 0.0026 * \Delta BBPen_{2001-02}$$

$$\Delta GDP_{04-05} = 3.81e-07 * (GDP/Pop)_{2000} + 0.395 * \Delta Pop_{2000-06} + 0.0025 * \Delta BBPen_{2001-02}$$

The β coefficient diminishes over time indicating a reduction in the intensity of broadband impact on GDP

The regression results for both regions illustrate the two different impact patterns

Growth of GDP

Dependent Variable: Growth of GDP between 2003 and 2006

$$G_GDP (03-06) = 1 * GDP_Capita_2000 + 2 * G_POP (00-06) + 3 * G_BBPEN (02-03)$$

	Total	Low Penetration	High Penetration
GDP per Capita 2000 (* 1'000'000)	0.0261 (0.041)	0.0627 (0.121)	0.0185 (0.050)
Population growth (2000 - 2006)	0.6318 *** (0.075)	0.5311 *** (0.102)	0.7731 *** (0.116)
Broadband penetration growth (2002 - 2003)	0.0255 *** (0.002)	0.0238 *** (0.005)	0.0256 *** (0.003)
R ² adjusted	0.6317	0.6321	0.6305
Number of Observations	424	210	214

Note: ***, ** and * indicate a significance level of 1%, 10% and 15%.
Standard errors in parentheses.

Growth of Employment

Dependent Variable: Growth of Employment between 2003 and 2006

$$G_EMP (03-06) = 1 * GDP_Capita_2000 + 2 * G_POP (00-06) + 3 * G_BBPEN (02-03)$$

	Total	Low Penetration	High Penetration
GDP per Capita 2000 (* 1'000'000)	0.0362 * (0.024)	-0.0066 (0.072)	0.0030 (0.029)
Population growth (2000 - 2006)	1.0481 *** (0.044)	1.1265 *** (0.061)	0.9072 *** (0.066)
Broadband penetration growth (2002 - 2003)	0.0020 * (0.001)	0.0027 (0.003)	0.0061 *** (0.002)
R ² adjusted	0.6065	0.6597	0.5557
Number of Observations	424	210	214

Note: ***, ** and * indicate a significance level of 1%, 10% and 15%.
Standard errors in parentheses.