**Columbia Business School**

# Broadband stimulus and the economy

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*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 |
|---|---|---|
| • The construction of broadband network has important direct and indirect employment effects<br><br>• The induced effects of network construction magnify the total impact of network deployment<br><br>• Revenue "leakage" varies by country<br><br>• Once broadband is deployed positive externalities have also significant economic impact | • How many jobs can be lost as a result of broadband induced capital-labor substitution?<br><br>• What is the economic impact in advanced industrialized vs. rural regions? | • What is the relationship between faster broadband speeds and economic output and employment?<br><br>• 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** | • Employment and economic production generated in the short term in the course of deployment of network facilities | • Telecommunications technicians<br>• Construction workers<br>• Civil and RF engineers |
| **Indirect jobs and output** | • Employment and production generated by indirect spending (or businesses buying and selling to each other in support of direct spending) | • Metal products workers<br>• Electrical equipment workers<br>• Professional Services |
| **Induced jobs and output** | • Employment and production generated by household spending based on the income earned from the direct and indirect effects | • Consumer durables<br>• Retail trade<br>• Consumer services |

## 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 | ✕ | 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., P. Zenhäusern, S. Suter, P. Mahler and S. Vaterlaus (2008). *Economic Modeling 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
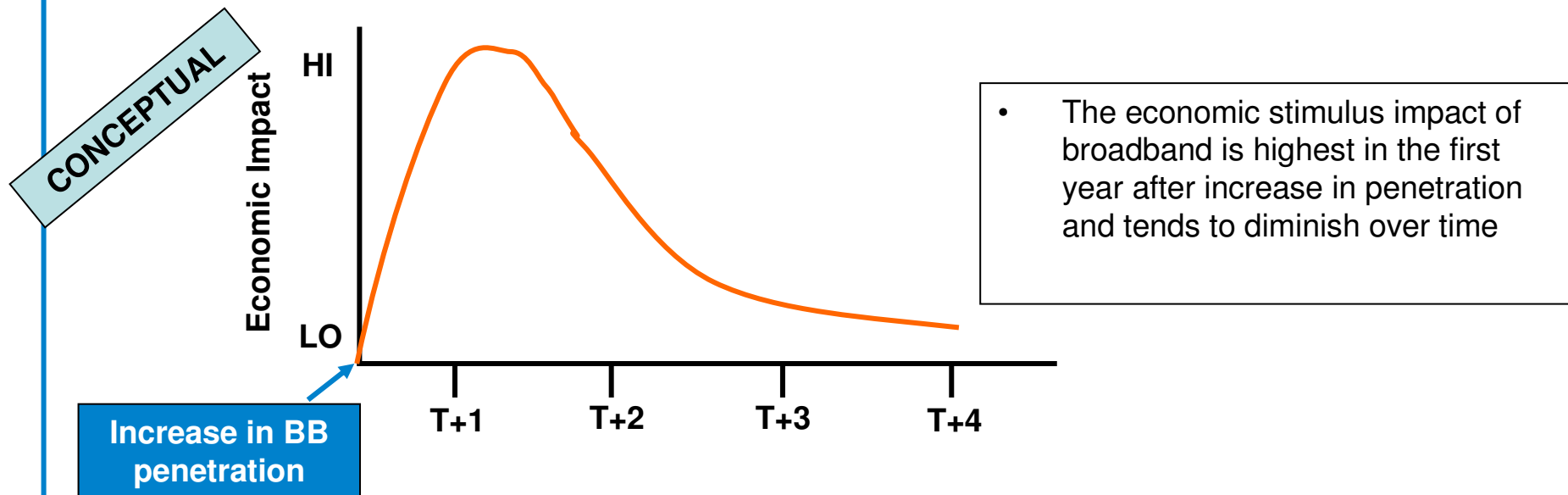
(*) (Direct + indirect)/direct
(**) (Direct + indirect + induced)/direct

## However, the externalities derived from broadband are significantly higher

| EFFECT | DESCRIPTION | EMPLOYMENT EXAMPLES |
|---|---|---|
| **Productivity** | • Improvement of productivity as a result of the adoption of more efficient business processes enabled by broadband | • Marketing of excess inventories<br>• Optimization of supply chains |
| **Innovation** | • Acceleration of innovation resulting from the introduction of new broadband-enabled applications and services | • New applications and services (telemedicine, Internet search, e-commerce, online education, VOD and social networking)<br>• New forms of commerce and financial intermediation |
| **Value chain recomposition** | • Attract employment from other regions as a result of the ability to process information and provide services remotely | • Outsourcing of services<br>• Virtual call centers<br>• Core economic development clusters |

# 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



CONCEPTUAL

Economic Impact — HI / LO

T+1   T+2   T+3   T+4

Increase in BB penetration

- The economic stimulus impact of broadband is highest in the first year after increase in penetration and tends to diminish over time

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

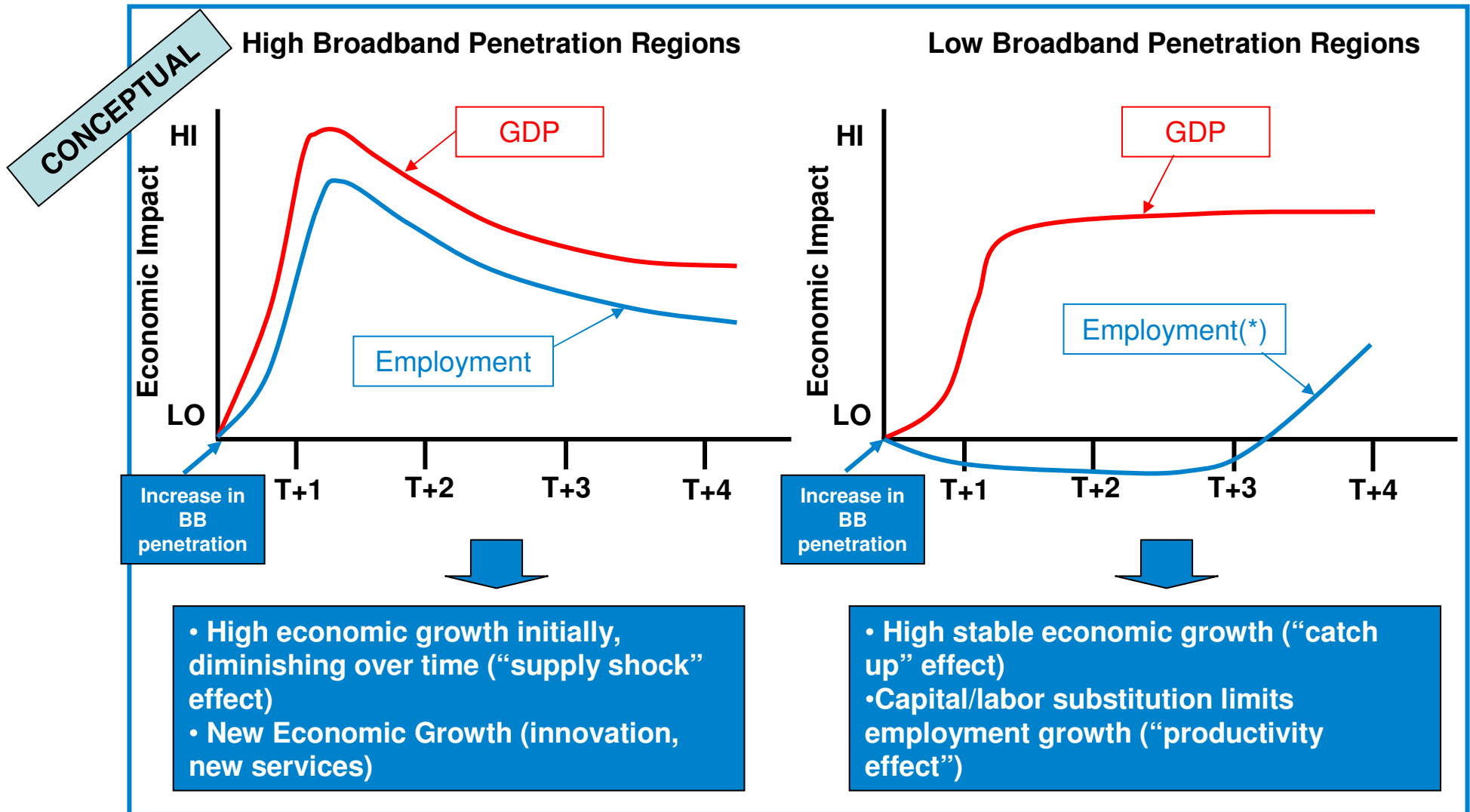| COUNTRY | STUDY | DATA | EFFECT |
|---|---|---|---|
| Germany | ●Katz et al. (2009) | 2000-2006 for Landkreise | An incremental penetration of broadband of 1% yields 0.026% incremental GDP growth |
| United States | ●Lehr et al. (2005) | 1998-2002 for US postal codes | Availability of broadband at 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" |
| | ●Shideler et al. (2007) | Disaggregated county data for state of Kentucky for 2003-4 | An increase in broadband penetration of 1% contributes to total employment growth ranging from 0.14% to 5.32% depending on the industry |
| | ●Thompson et al. (2008) | 2000-2006 for 48 US states | Positive employment generation effect varying by industry |
| OECD | ●Koutroumpis (2009) | 2002-2007 for 22 OECD countries | An increase in broadband penetration of 1% yields 0.025% increase in economic growth |

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

CONCEPTUAL

**High Broadband Penetration Regions**

Economic Impact

HI

GDP

Employment

LO

Increase in BB penetration

T+1    T+2    T+3    T+4

- **High economic growth initially, diminishing over time ("supply shock" effect)**
- **New Economic Growth (innovation, new services)**

**Low Broadband Penetration Regions**

Economic Impact

HI

GDP

Employment(*)

LO

Increase in BB penetration

T+1    T+2    T+3    T+4

- **High stable economic growth ("catch up" effect)**
- **Capital/labor substitution limits employment growth ("productivity effect")**

*(*) 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. (2008) | 2000-2006 for 48 US states | Pointed out to the potential existence of a substitution effect between capital and labor that is stimulated by broadband deployment; which could materialize differentially by industry |
| | ●Shideler et al. (2007) | Disaggregated county data for state of Kentucky for 2003-4 | The broadband impact is negative and significant (0.34%) for Tourism, which suggests that broadband deployment enables firms to substitute technology for labor in this industry |

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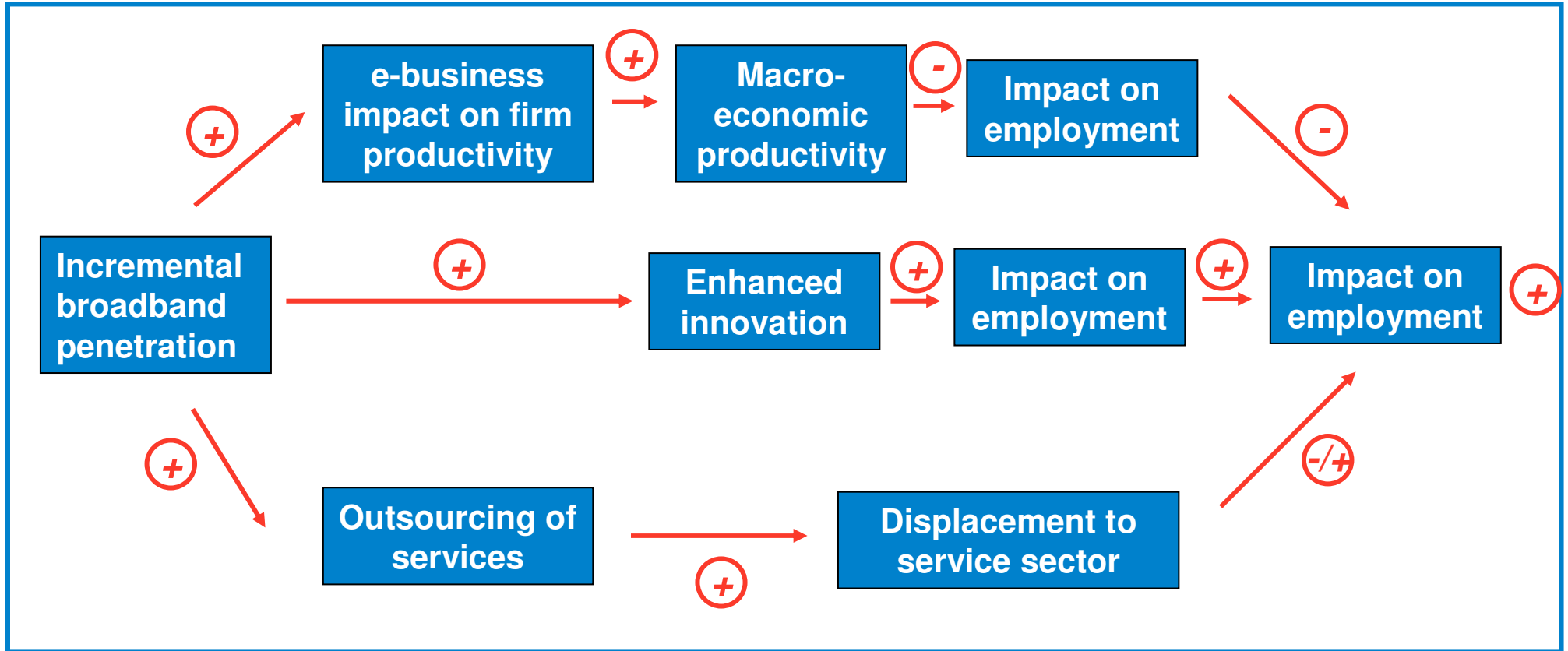


*Note: This causality chain was adapted from a model originally developed by Fornefeld et al., 2008 in a report for the European Commission*

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# 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 at 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

**BROADBAND PENETRATION IMPACT**
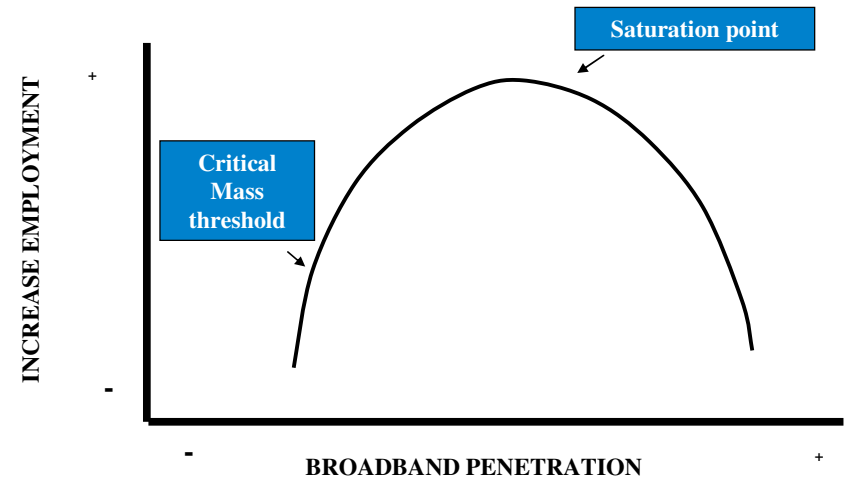
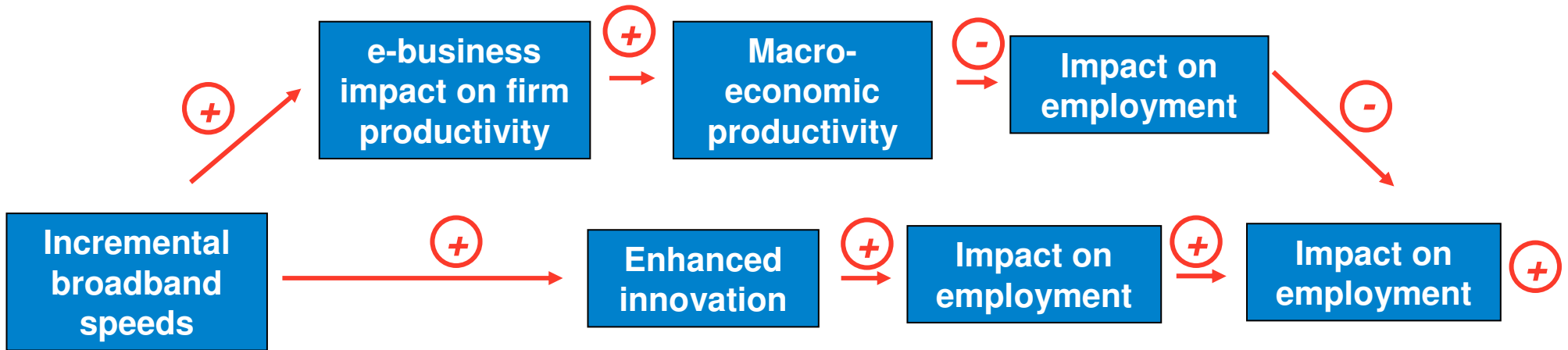# Two pieces of evidence so far regarding potential saturation

## 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

Incremental broadband speeds → (+) → e-business impact on firm productivity → (+) → Macro-economic productivity → (-) → Impact on employment → (-)

Incremental broadband speeds → (+) → Enhanced innovation → (+) → Impact on employment → (+) → Impact on employment → (+)

| 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 |
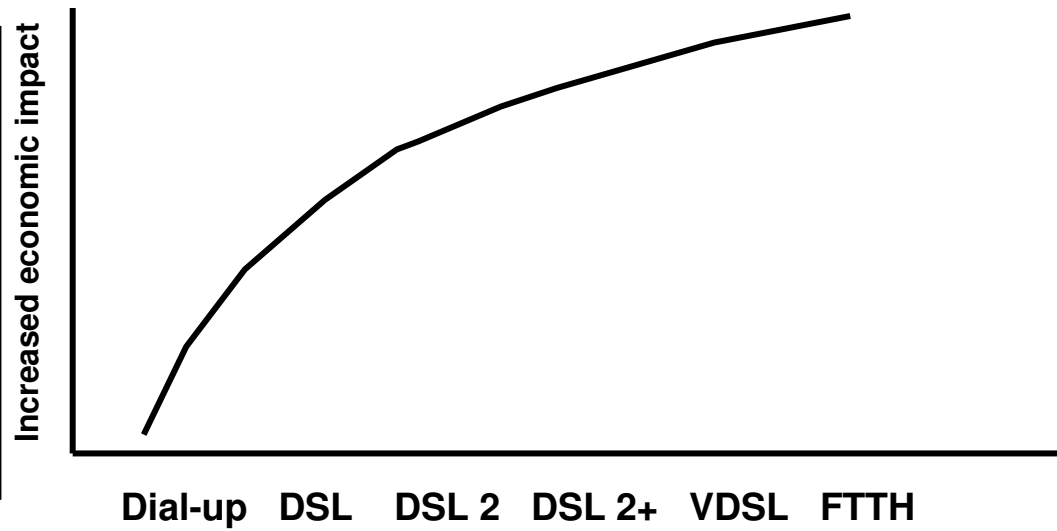
*Source: SQW (2006)*

Increased economic impact

Dial-up   DSL   DSL 2   DSL 2+   VDSL   FTTH

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# 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

## BROADBAND AS A DRIVER OF GDP

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

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

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

| Dependent Variable: Growth of GDP between 2003 and 2006 $G\_GDP (03-06) = \beta1 * GDP\_Capita\_2000 + \beta2 * G\_POP (00-06) + \beta3 * G\_BBPEN (02-03)$ | |
|---|---|
| | 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.*

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

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

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

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

**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 | 0.0627 | 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 |

*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 * | -0.0066 | 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 |

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

*Standard errors in parentheses.*