Columbia Business School

Broadband stimulus and the economy

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Broadband policy in the 21st century:
A Transatlantic Perspective

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In response to the economic crisis, governments have launched infrastructure stimulus programs with an ICT focus

COUNTRY	ICT FOCUS
United States	• Launched a Broadband Stimulus program focused on providing service to unserved and underserved areas for $7.2 billion
Australia	• Government is planning to spend A$ 11 billion of total A$ 43 billion required for construction of the National Broadband Network
Singapore	• Government will provide a grant of S$ 750 million of S$ 2.2 billion to support the roll-out of the fiber network
Germany	• Government has announced a National Broadband Strategy with the objective to have nationwide capable broadband access (1 Mbps) no later than by the end of 2010 and provide to 75 percent of German households access to a broadband connection of at least 50Mbps by 2014 (estimated investment: Euros 36 billion)
Sweden	• Broadband government promotion comprised financial incentives to municipalities to fund 2/3 of total NGN investment (Euros 864 million)
Colombia	• $ 0.29 b ($0.16 b in universal telephony, $0.05 b in ICT education, $0.03 b in Broadcasting, $0.03 b in computing education and $0.02 b in e-government)
Portugal	• Government announced an 800-million-euro credit line for the roll-out of NGAN. This is part of an the first step in a 2.18-billion-euro plan to boost the country's economy.
Ireland	• The government will invest 322 million in a National Broadband Scheme aimed at completing country coverage
Canada	• Has relied on four programs to promote broadband development resulting in an overall investment of C$ 300 million

Sources: Government announcements

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 ●The induced effects of network construction magnify the total impact of network deployment ●While in certain countries total industrial output generated by the deployment of broadband is significant, the proportion of imported goods is increasing, thereby reducing the amount of jobs being created ●Network externalities once broadband is deployed have also significant economic impact	●How many jobs can be lost as a result of productivity induced broadband? ●A broadband investment program could create new jobs in the targeted region but result in job losses in another one, with limited incremental national impact: what is the impact?	●What is the relationship between faster broadband speeds 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

- 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 • Construction workers • 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 • Electrical equipment workers • 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 • Retail trade • Consumer 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	37,300	31,000	59,500	127,800	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

(*) (Direct + indirect)/direct
(**) (Direct + indirect + induced)/direct

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.* unpublished report; Katz, R., S. Vaterlaus, P. Zenhäusern, S. Suter and P. Mahler (2009). *The Impact of Broadband on Jobs and the German Economy,* forthcoming

As expected, if funds were to be invested in roads and bridges, the number of jobs created would be somewhat higher because of construction intensity

UNITED STATES: CONSTRUCTION EFFECTS OF BROADBAND VS. ROADS AND BRIDGES

			BROADBAND	"ROADS AND BRIDGES"
Investment (all $ numbers in millions)			$ 6,390	$ 6,390
Employment	Direct effect	Jobs in equipment mfr, construction and telecoms	37,200	48,500
	Indirect effect	Jobs in other sectors	31,000	33,900
	Induced effect	Jobs triggered by spending	59,600	69,600
	Total effect	*Jobs in all sectors*	127,800	152,000
Total Industry Output	Direct effect	Investment	$ 6,390	$ 6,390
	Indirect effect	Additional goods generated	$ 5,291	$ 5,386
	Total effect	*Total additional goods produced*	$ 11,681	$ 11,776
	Domestic		$ 11,104	$ 11,319
	Imported		$ 577	$ 457
	Multiplier	(Direct + Indirect)/Direct ($1 of investment results in $x of industrial output)	1.83	1.84

Roads and bridges generate more direct jobs because they are more construction intensive
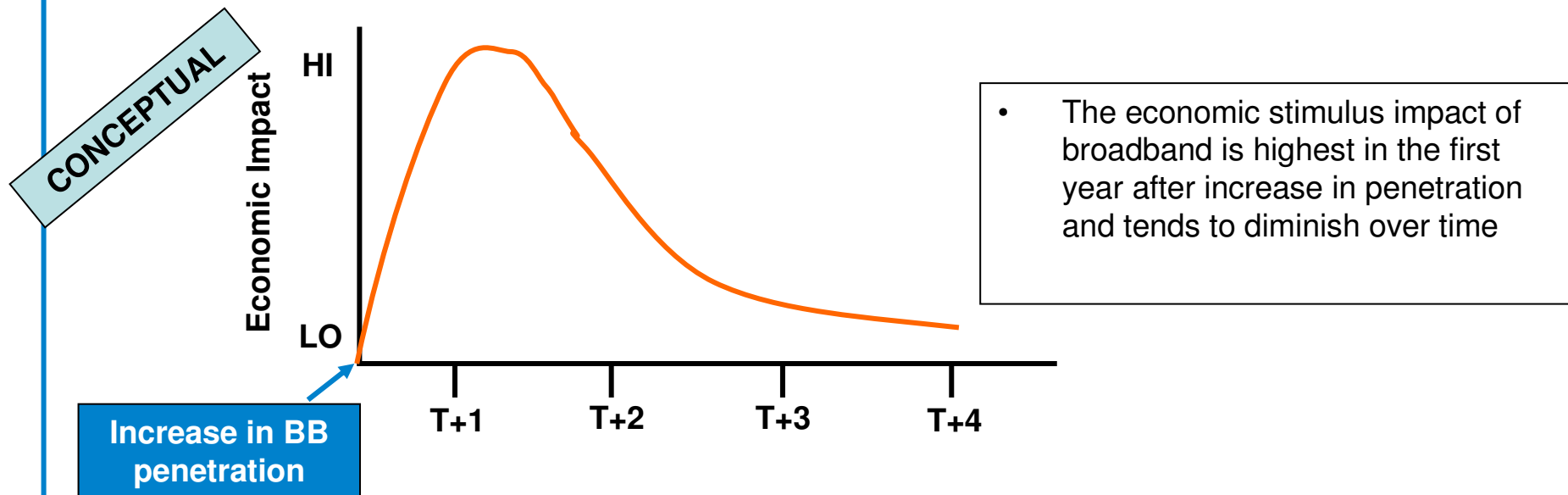
Roads and bridges have less investment leaked overseas

Source: Katz, R. and Suter, S. (2009)

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 • 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) • 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 • Virtual call centers • 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 and job creation

  - 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

Increase in BB penetration

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

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

BROADBAND AS A DRIVER OF GDP

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

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

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

Dependent Variable: Growth of GDP between 2003 and 2006

$$G\_GDP\,(03\text{-}06) = \beta1 * GDP\_Capita\_2000 + \beta2 * G\_POP\,(00\text{-}06) + \beta3 * G\_BBPEN\,(02\text{-}03)$$

	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
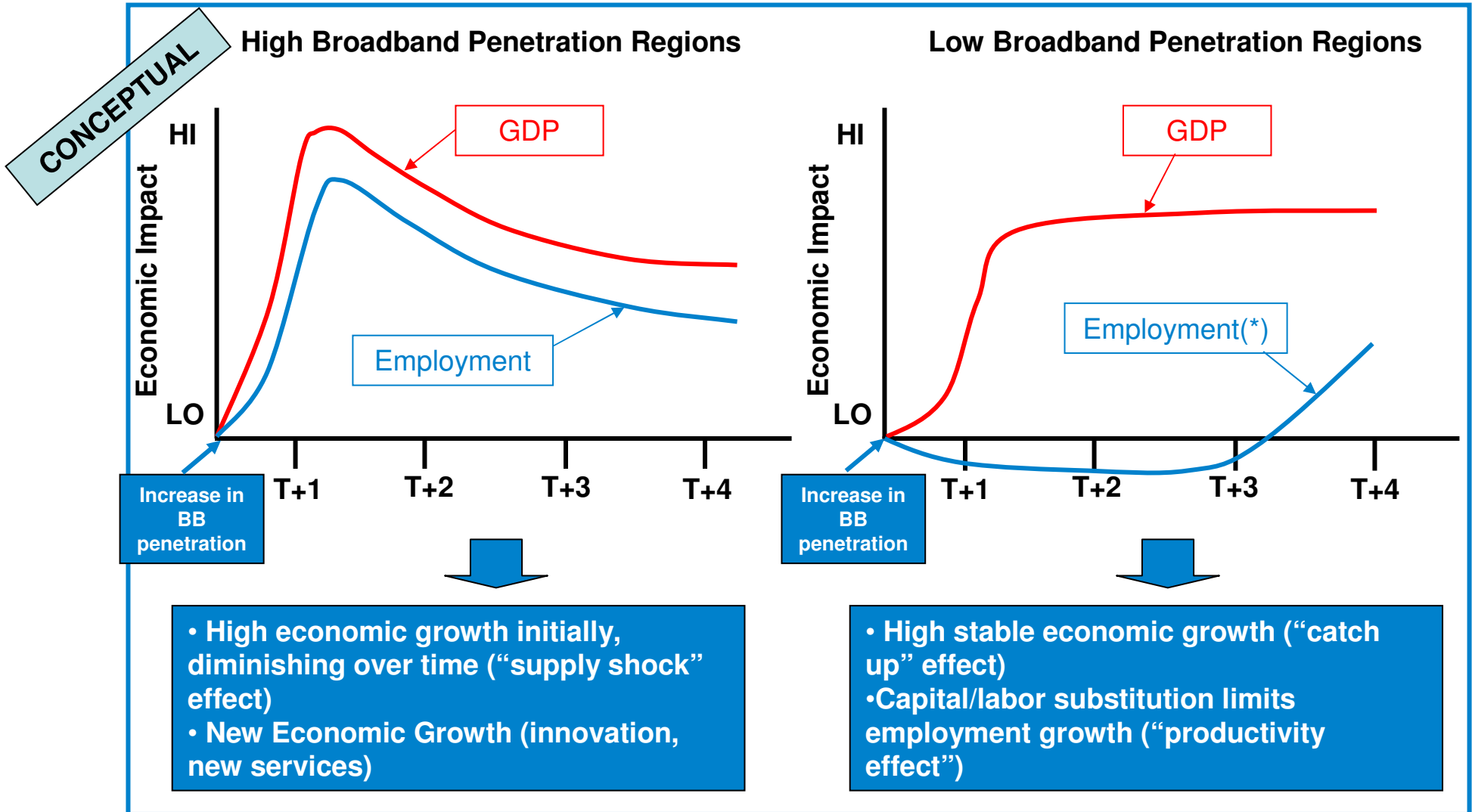
Agenda

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We have determined that the type of broadband network effects vary by region of the country

	High penetrated regions	Low penetrated regions
Impact on GDP growth	Very high in the short term and reducing over time	• Lower than high penetrated areas in the short term but catching up to a similar level as highly penetrated areas
Impact on employment	Very high in the short term and reducing over time	• Positive although with low significance
Implications	• An increase in broadband penetration in highly penetrated areas has a strong impact because the economy is so developed that it can immediately utilize the newly deployed technology • The fact that employment <u>and</u> GDP grow in parallel indicate that broadband is having a significant impact on innovation and business growth to overcome any employment reduction resulting from productivity effects	• In low penetrated areas, the increase in broadband penetration takes longer to materialize in economic growth because the economy requires 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 high penetrated • The fact that employment growth is negative indicates that productivity increase is the most important network effect at work, resulting in employment reduction

Different economic impact profiles at the regional level result from different levels of broadband penetration

CONCEPTUAL

High Broadband Penetration Regions

Economic Impact — HI / LO

GDP

Employment

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 / LO

GDP

Employment(*)

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

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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

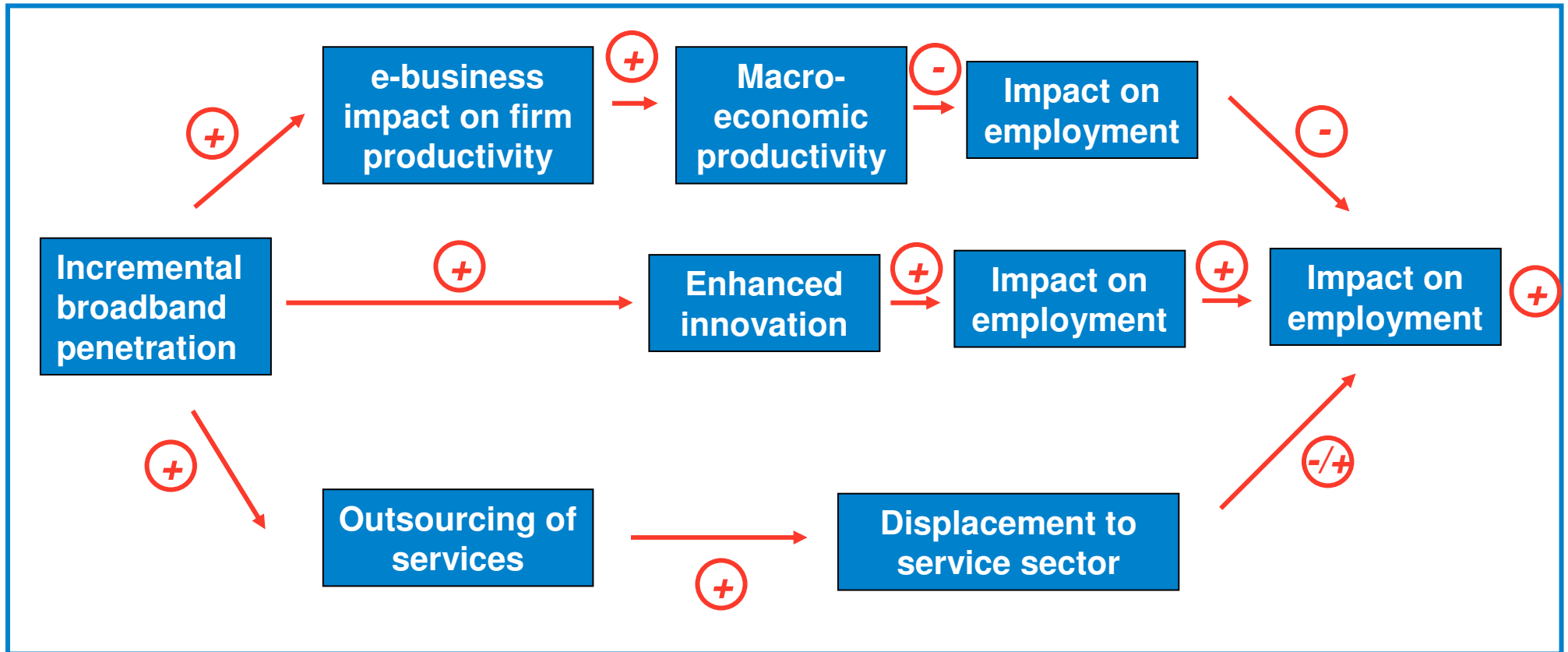G_EMP (03-06) =   1 * GDP_Capita_2000 +   2 * G_POP (00-06) +   3 * G_BBPEN (02-03)

	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.

An increase in broadband penetration of 5-7% results in 0.026 percentage points increase in output and over 160,000 jobs in a three year period

	High Penetrated Regions	Low Penetrated Regions (white zones and grey zones)	Total	Annual Impact
2008 broadband penetration (by population)	31.0 %	24.8 %	27.9 %	
Penetration resulting from National Broadband Strategy at 2014 targets	38.8 %	31.1 %	34 %	
Increase in penetration	25.1 %	25.4 %	21.9 %	
Incremental Impact on economic growth rate (3 years)	1.93 %	1.82 %	1.90 %	
Additional GDP (2011-12-13)	€ 32,809 Mio	€ 14,375 Mio	€ 47,184 Mio	€ 15.7 Mio
Impact on employment growth	0.00137	0.000561	0.00043	
Additional jobs (2011-13)	132,000	30,000	162,000	54,000

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" findings of research of the impact of telecommunications on the economy, 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, at least according to what was found by Lehr et al. (2006), the relation between penetration and employment should not be linear "because broadband will be adopted within a state first by those who get the greatest benefit (while) late adopters within a state will realize a lesser benefit"

- 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.
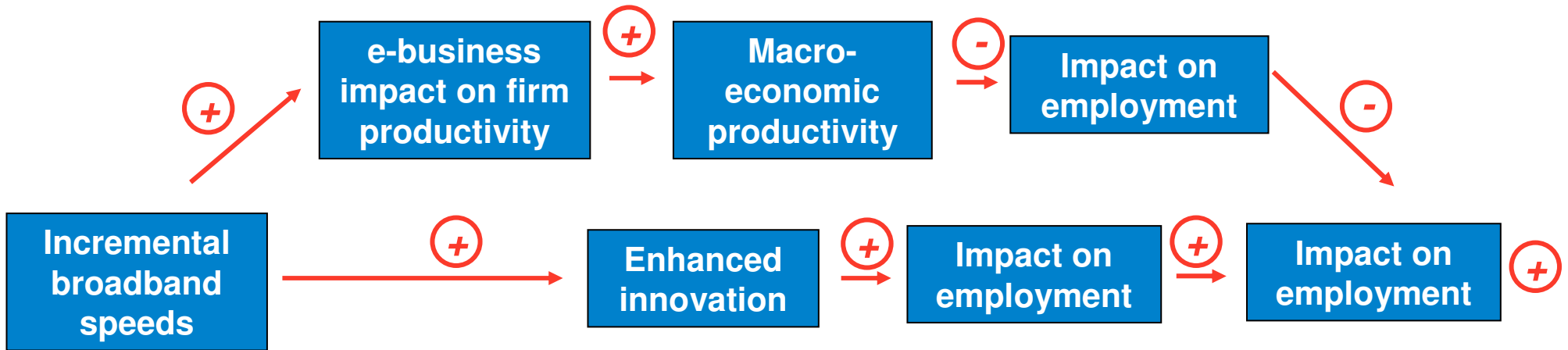
BROADBAND PENETRATION IMPACT
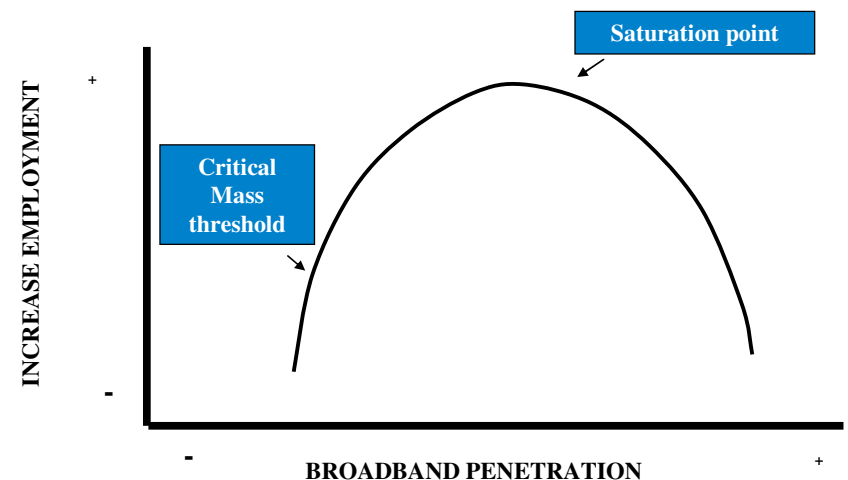
Example of saturation effect due to penetration (%)
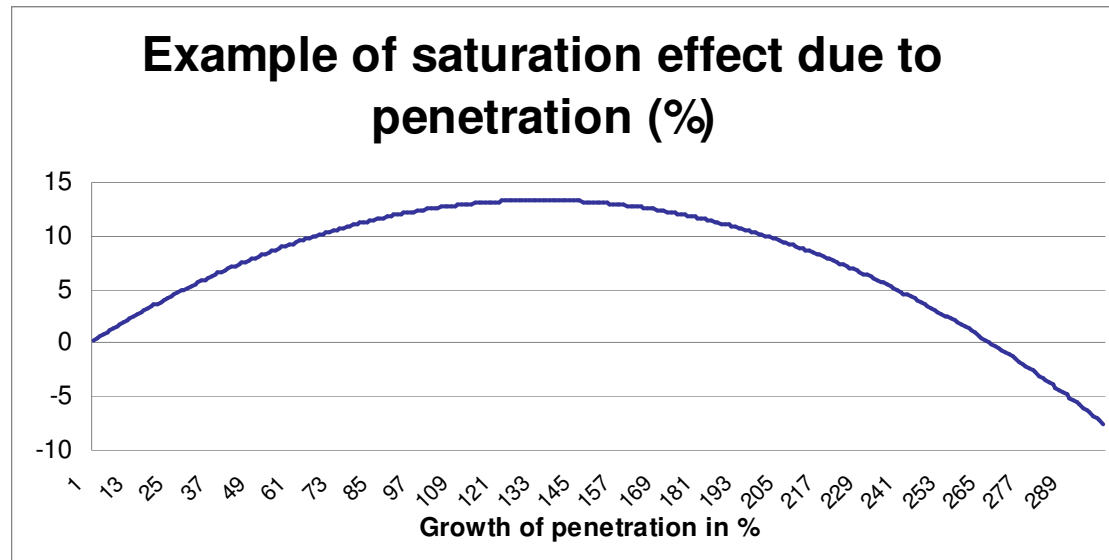
Coefficients	Low penetration	High penetration	Example
Penetration per capita growth	0.02833	0.03473	0.20000
Significance level: P>|t|	*0.09*	*0.02*	
Penetration per capita growth squared	-0.00643	-0.01665	-0.00075
Significance level: P>|t|	*0.78*	*0.53*	

Finally, what is the incremental socio-economic impact of faster and better broadband service

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

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
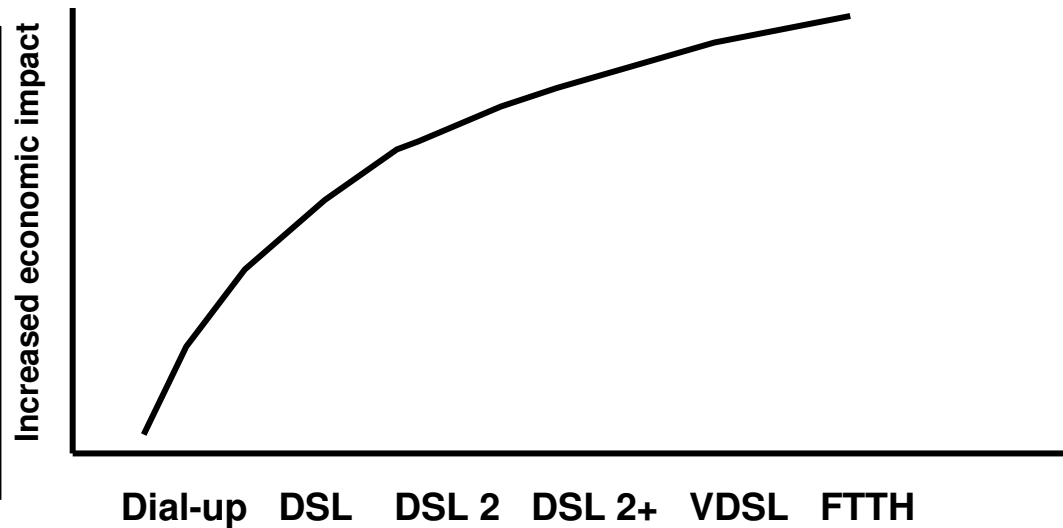
Source: SQW (2006)

Increased economic impact (y-axis)

Dial-up   DSL   DSL 2   DSL 2+   VDSL   FTTH

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Why Should Governments Invest in NGN in the Current Environment?

- 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

    - Network effect multipliers exhibit higher level of uncertainty and therefore have to be ranged

    - Employment multipliers: between 1.92 and 3.42

    - 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

Where should government stimulus be focused?

- Supply vs. demand programs?

- High penetrated areas vs. low penetrated areas?

- Digital divide or innovation?

- Role of private sector: 50% Public Private Partnerships or state focus (medium term: Australia, or long term)?

- Grants (US) or loans (Portugal)?

- Technology neutral (US) or specific (Singapore, Australia)?

- Selection and evaluation metrics: employment, productivity (difficult to measure), digital divide (Ireland, US)

Policy and research implications

- Job fulfillment is driven by success in implementing job creation and retention programs that could be enabled by broadband

- Policy implications:

  - Coordinate broadband deployment with job creation and retention programs

  - Refine criteria for selecting areas to deploy broadband based on the stimulus

  - Centralize program evaluation and grant allocation

  - Develop systematic tests based on social and economic criteria to evaluate the return on the investment

- Research agenda:

  - Economic impact of NGAN?

  - Is there a saturation effect limiting broadband impact?