The economic impact of broadband speed: Comparing between higher and lower income countries

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The economic impact of broadband speed: Comparing between higher and lower income countries

- Filling the gap by
  1) Empirically investigating the economic impact of broadband speed
  2) Comparing the impact between higher and lower income countries

- Dividing the studies into two papers, investigating in micro-level and macro-level

The economic impact of broadband speed: Comparing between higher and lower income countries

- ‘Impact of broadband speed on household income: Comparing OECD and BIC’

- ‘Impact of broadband speed on economic outputs: An empirical study of OECD countries’

The impact of broadband speed on economic outputs: An empirical study of OECD countries

Introduction

- There is a need for faster internet and to ensure that citizens can access the services they want (EC, 2010)

- Not only broadband penetration that matters, but also other characteristics such as different speed transmission, type of connection, quality of service and service provider (Middleton, 2013)

- Only a few studies focusing on the effect of higher broadband speed on different economic impacts, compared with the impacts of broadband penetration

Aims

- Investigating the relationship between broadband speed and economic outputs at macro-economic level

- Adding more knowledge and empirical evidence to the broadband speed studies, which have so far been limited

Research questions

- What are the impacts of broadband speed on economic output such as GDP per capita?

- How the impacts of broadband speed on economic output are different between countries with higher and lower income?

Broadband speed

- 300 bps (1964), 2.4 kbps (1986), 28.8 kbps (1995), 1.5 Mbps (mid-2000s)

Benefits of faster speed

- Significantly faster file transfers, both sending and receiving
- Enabling video streaming applications
- High quality real-time communication
- Enabling users to use many applications at the same time

Source: Atkinson et al. (2009)

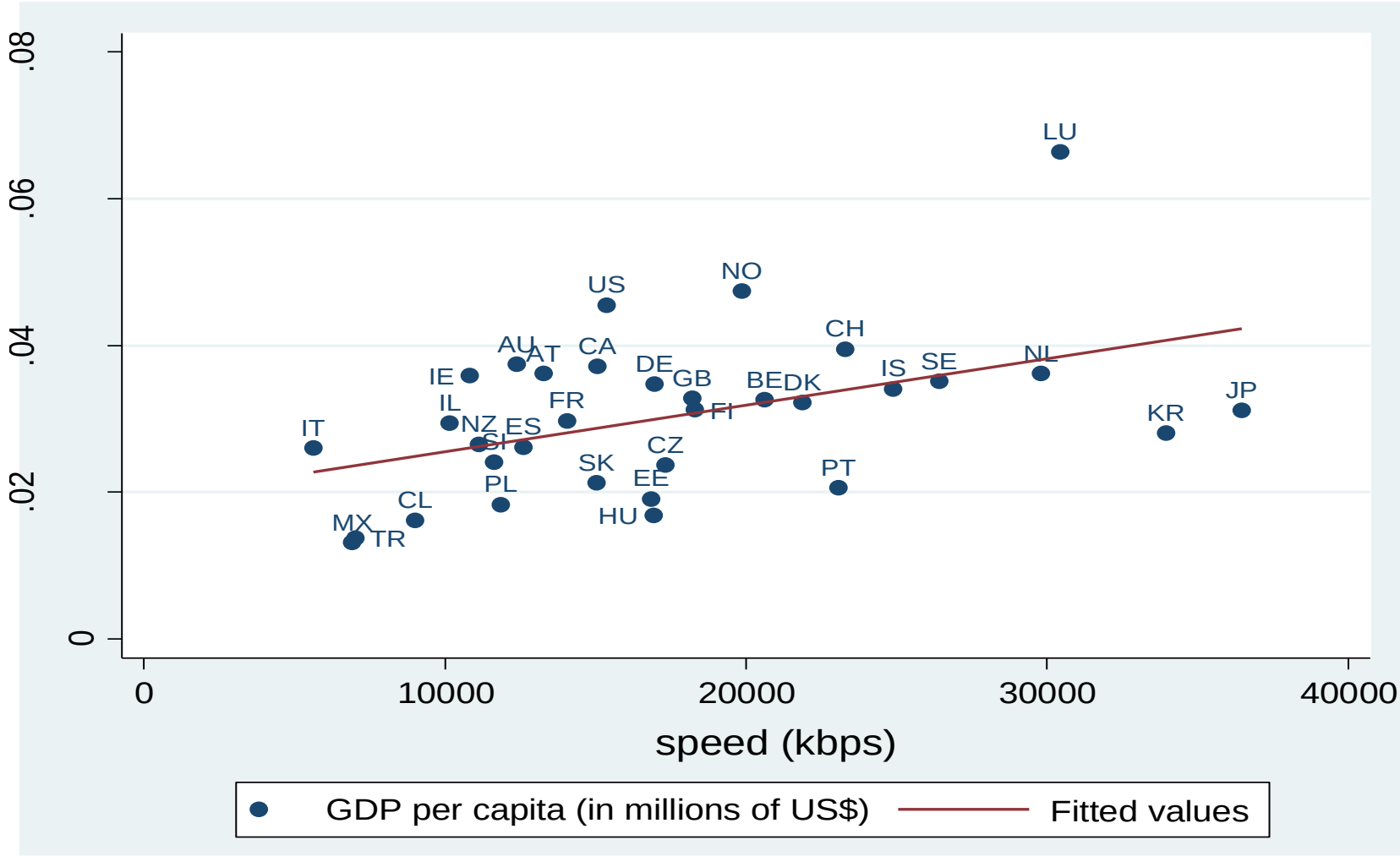
Broadband speed (2)

Benefits on economy

- Direct job and act creation through the broadband development project
- Externalities at both business and household level (productivity gains in firms and higher household incomes in residential adoption)
- Benefits in the form of consumer surplus
- Benefits through other sectors such as access to the public, entertainment, education, health care and banking services

Source: ITU(2012)

Broadband speed & GDP per capita (Q4 2012)



Previous literature

- Katz et al. (2010): Germany achieving both the broadband penetration and speed targets, there will be more than 960,000 additional jobs and output worth more than 170 billion euro.

- Rohman and Bohlin (2012): Increasing the speed in the OECD countries stimulates GDP growth. The impacts depend on the size of the coefficient of broadband speed and the existing economic growth in each country

- Forzati and Mattsson (2012): Increasing in the ratio of the population that lives within 353 metres of a fibre-connected premise contributes positively to job employment from 0%-0.2% after two and a half years

Models & Variable selection

Endogeneity problem

Author(s)	Main variable(s)	Methods to cope with the endogeneity problem/comments
Röller and Waverman (2001)	telecommunication infrastructure	Jointly estimated supply and demand with production equation (estimated with GMM)
Lehr et al. (2005)	broadband availability/ broadband penetration	Matching control groups and treatment groups by estimating the average treatment effect
Crandall et al. (2007)	broadband infrastructure	Only use OLS for simplicity, however, the authors stated that more complex methods failed to provide any significant difference from OLS
Koutroumpis (2009)	broadband infrastructure	A simultaneous approach by the jointly estimated supply and demand with a production equation (using GMM and 3SLS)
Czernich et al. (2011)	broadband introduction/ broadband penetration	Instrumental variable (IV) approach using the cable TV and voice telephone penetration rate as instruments
Thompson Jr. and Garbacz (2011)	Fixed and mobile broadband lines per household	Estimating the predicted value for fixed broadband and mobile broadband using two-stage panel data regression (2SLS)
Rohman and Bohlin (2012)	broadband speed	Two-stage panel data regression (2SLS) approach using broadband penetration, broadband price and telecom revenue to estimate broadband speed

Models & Variable selection (2)

- While there are several methods to reduce endogeneity biases, truly exogenous variables are limited, and dealing with the endogeneity problem is usually successful on a small scale. The effects of broadband on economic outputs also differ by country (Thompson Jr. and Garbacz, 2011)

- Simple OLS estimation (with country dummy) & instrumental variable approach (using fibre ratio as an instrument for broadband speed) are added for checking robustness of the results

Models & Variable selection (3)

- Models adapted from Thompson Jr. And Garbacz (2011) and Rohman and Bohlin (2012) – 2SLS on panel data using predict value of broadband speed

- Broadband speed = g(fixed broadband penetration, fibre ratio, population density, telecom revenue, GDP growth)

- GDP per capita = h(capital, labour, broadband speed, economic freedom index, urban ratio, country dummy for high and low income)

Models & Variable selection (4)

Variable(s)	This study	Thompson Jr. & Garbacz (2011)	Rohman & Bohlin (2012)
GDP	X	X	X
capital	X	X	
labour	X	X	X
broadband speed	X		X
economic freedom index	X	X	
urban ratio	X		X
country dummy for high and low income	X	X	

Models & Variable selection (5)

- Adding from Thompson Jr. And Garbacz (2011) and Rohman and Bohlin (2012), percentage of fibre subscription on fixed broadband subscription is also chosen to estimate the first step of broadband speed because fibre technology can represent the highest speed in comparison to other technologies, at least during the study period 2008-2012

- This study further analyses impacts of broadband speed in two groups of OECD countries, lower and higher income

Models & Variable selection (6)

$$lnspeed_{it} = \beta_0 + \beta_1 fixed\_penetration_{it} + \beta_2 fibre\_percentage_{it} + \beta_3 GDPgrowth_{it} + \beta_4 population\_density_{it} + \beta_5 telecom\_revenue_{it} + \varepsilon_{it} \quad (1)$$

$$lngdpc_{it} = \beta_0 + \beta_1 lncapital_{it} + \beta_2 labour_{it} + \beta_3 lnspeed_{it} + \beta_4 economic\_freedom_{it} + \beta_5 urban_{it} + \beta_6 income\_dummy_{it} + \varepsilon_{it} \quad (2)$$

Data sources

Data used during the period of 2008-2012

Sources	Variable(s)
World Bank	Labour force ratio Urban population ratio GDP growth population density
OECD	GDP per capita Fixed capital Fixed broadband penetration Fibre subscription ratio Telecom revenue
Ookla speedtest http://www.speedtest.net/	Broadband speed
The heritage foundation http://www.heritage.org/	The economic freedom index

Variable description

Variable	Description
$lngdpc_{it}$	the natural logarithm function of GDP per capita in thousands of US$ for country *i* at time *t*, volume estimates, fixed PPPs, OECD reference year, annual levels, seasonally adjusted
$lncapital_{it}$	the natural logarithm function of gross fixed capital formation per capita in thousands of US$ for country *i* at time *t*, volume estimates, fixed PPPs, OECD reference year, annual levels, seasonally adjusted
$labour_{it}$	the ratio of total labour force to total population for country *i* at time *t*
$economic\_freedom_{it}$	the index of economic freedom, including ten freedom criteria from property rights to entrepreneurship (according to the heritage foundation website) for country *i* at time *t*
$urban_{it}$	the percentage of urban population per total population for country *i* at time *t*
$income\_dummy_{it}$	the dummy variable for high income countries for country *i* at time *t;* if GDP per capita > 30,000 US$ = 1, otherwise = 0
$lnspeed_{it}$	the natural logarithm function of average broadband download speed in kilobits per second (Kbps) for country *i* at time *t*
$fixed\_penetration_{it}$	fixed broadband penetration per household for country *i* at time *t*
$fibre\_percentage_{it}$	the percentage of subscriptions of fibre technology of the total fixed broadband subscriptions for country *i* at time *t*
$GDPgrowth_{it}$	GDP growth rate for country *i* at time *t*
$population\_density_{it}$	population density (population per km^2 of land area) for country *i* at time *t*
$telecom\_revenue_{it}$	telecommunication revenue as a percentage of GDP from the previous year for country *i* at time *t*

Empirical results (1)

Variable(s)	OLS	IV-FE	IV-RE	2SLS-FE	2SLS-RE
Dependent variable: $lngdpc_{it}$					
Independent variables					
$lncapital_{it}$	0.2173***	0.2466***	0.2429***	0.1894***	0.1970***
$labour_{it}$	0.4635***	-0.1223	0.2090	0.5533	0.6809
$lnspeed_{it}^{a}$	0.0147***	0.0479***	0.0352***	0.0807***	0.0699***
$ec\_freedom_{it}$	0.0016**	0.0030***	0.0029***	0.0017	0.0018
$urban_{it}$	0.0091***	-0.0049	0.0038*	-0.0065*	0.0025
$income_{it}$	0.0251***	0.0187*	0.0360***	0.0212***	0.0344***
constant	1.7092***	2.6794***	1.9661***	2.3649***	1.6742***
R-squared	0.9973	0.5185	0.7592	0.6940	0.7419
Prob>F/Chi2	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Hausman test	-	Chi2=330.34***		Chi2=109.50***	
obs	654	654	654	520	520

Empirical results (2)

Variable(s)	2SLS-FE(Low)	2SLS-RE(Low)	2SLS-FE(High)	2SLS-RE(High)
Dependent variable: $lngdpc_{it}$				
Independent variables				
$lncapital_{it}$	0.2416***	0.2498***	0.1590***	0.1651***
$labour_{it}$	0.7272**	0.5526**	-0.3076	-0.3277
$lnspeed_{it}^{a}$	0.0975***	0.0906***	0.0591***	0.0507***
$ec\_freedom_{it}$	0.0042**	0.0037**	0.0011	0.0009
$urban_{it}$	-0.0107**	-0.0026	-0.0122**	-0.0065***
constant	1.9422***	1.5338***	3.8362***	3.4621***
R-squared	0.8167	0.6209	0.6106	0.3659
Prob>F/Chi2	0.0000***	0.0000***	0.0000***	0.0000***
Hausman test		Chi2=44.94***		Chi2=13.16**
obs	248	248	272	272

Empirical results (3)

- Capital and broadband speed variables have significantly positive sign as expected
- Labour and economic freedom index variables are not statistically significant in the overall model; however, they are positively significant in lower income countries
- Urban ratio variable surprisingly have negative coefficients. (as well as in Rohman and Bohlin, 2012)

Discussion & Limitations

- All models provide significant positive coefficients for broadband speed variable
- Broadband speed has greater impact in countries with lower income than countries with higher income
- An increase in broadband speed leading to an increase in GDP; however, these exact numbers of the coefficients should be interpreted with caution
- The causality of high speed broadband and economic outputs in all the models shows that the results are robust and that broadband speed does matter

Discussion & Limitations (2)

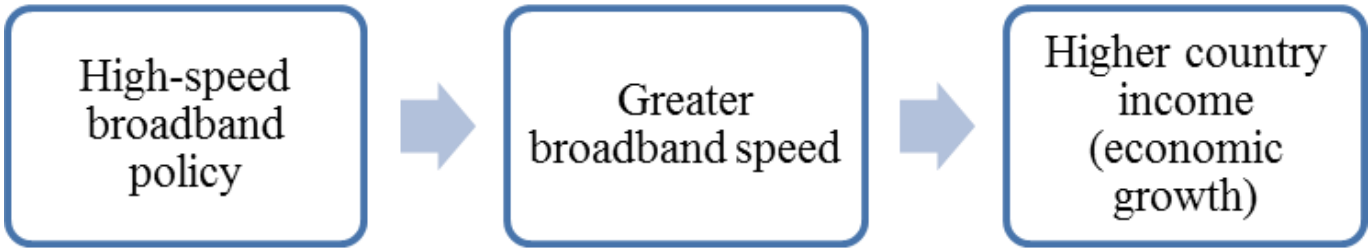
- Consistent with previous studies related to broadband speed (Katz et al., 2010, Rohman and Bohlin, 2012, and Forzati and Mattsson, 2012) that faster broadband speed encourages greater benefits for a country; in this case it stimulates higher GDP per capita.

- Some limitations on the data:
  1) Greece is omitted from the analysis due to the missing data on GDP and cost of capital
  2) The mobile broadband penetration is omitted from the first stage of the analysis because of limited availability

Research implication

- Achieving broadband penetration targets is still important, improving the quality of the services, such as greater broadband speed, also leads to higher economic outputs of the countries
- Emphasising the importance of higher broadband speed, especially in countries with lower income
- Supporting future research on broadband speed which is continuously growing
- Other characteristics such as quality of broadband services or type of broadband technology are also interesting for future research

Policy recommendation



To efficiently improve economic growth, broadband policy for high-speed broadband should be implemented and encouraged through all market players including infrastructure providers, services providers, content providers and end-users;

Policy recommendation (2)

Market player	Recommended policy
Broadband infrastructure	Rolling-out high-speed broadband is the important first step. Public funds may be needed if necessary
Broadband services	Regulation to promote competition in the market (choices of regulation differ country by country), particularly wireless services
Content and applications	Public services are the first important step to gain general broadband usage while more complex application can be applied to promote the use of high-speed services
End-users	Financial and digital literacy support to specific groups who need helps

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Thank you

Impact of broadband speed on household income: Comparing OECD and BIC

Main findings

- There is a required minimum level of broadband speed needed to gain benefits, 2-4 mbps for OECD countries and 0.5 mbps for BIC

- The benefits are not linear and continuous, but nonlinear and stepwise

- Households in advanced economies gain more leverage from broadband upgrades