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How to Define Economic Welfare in a Gigabit Society

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From Dial-Up to "Always On"

- From the **Dial-up** connection to **Fiber-to-the Home**, the Internet has been an **economic catalyst**, facilitating **innovation**, fostering **new business models** and enabling **productivity growth**.
- In the last 20 years the Internet changed our lives: the way we communicate, we accede to information, we work, we travel…
- The wide-spread dramatic and disruptive impact of the Internet has been enabled by substantial investments in deploying and upgrading **fast and super fast broadband** infrastructure.

INTRODUCTION

- The importance of fast broadband infrastructure to enable **beneficial economic spillovers** is amply recognized.

> *"High speed communications networks are a platform supporting **innovation** throughout the economy today in much the same way **electricity** and **transportation** networks spurred innovation in the past…*
> …high-speed broadband is increasingly considered a ***General Purpose Technology (GPT)*** *"*
>
> Enck and Reynolds, OECD Digital Economy Papers 164, 2009

The impacts of **previous waves of Internet** connectivity on economic welfare have been well documented. As others GPTs, high-speed broadband has the potential to be an **important driver of productivity gains**.

Welfare Impact of Network Deployment

Broadband infrastructure deployment yields direct and indirect effects with respect to GDP growth (Briglauer & Gugler 2018)

Direct Effects: deploying new network infrastructure results in additional **employment** and **production** that will increase further due to multiplier effects.

Indirect Effects: are related to the **adoption of services and applications** by firms and residential consumers (demand side).

- **Households** benefit via **easy** and **cheap** access to services (public administration, banking, …), to information, to e-learning materials.

- **Firms** may obtain relevant **cost savings** and **productivity gains** via more efficient processes, acceleration of innovation and launch of new products and services.

Empirical Evidence (I)

There is **strong empirical evidence** that diffusion of broadband infrastructure and services is an important driver of economic growth.

- *Koutroumpis (2009*): He estimated that **1%** increase in broadband adoption was responsible for **2,3%** increase in annual GDP growth (sample of 22 OCDE countries over the period 2002-2007.)

- *Czernich et al (2011)*: using a 25 OECD countries sample over the period 1996-2007, they estimate that a **10pp** increase in the rate of broadband adoption led to a **0.9pp to 1.5pp** increase in annual growth of GDP per capita.

- *Crandall and Jackson (2003)* conclude that long run benefits of first generation broadband may be **1% or higher** increment to GDP.

Empirical Evidence (II)

Koutroumpis (2009) found that impacts of fast broadband are higher in countries with relatively high levels of take-up (2002-2007):

Degree of penetration	Average impact of broadband on GDP growth	Impact of additional 10 lines per 100 people
Low (Greece, Italy)	0.15%	0.7%
Medium (Germany, UK)	0.23%	0.8%
High (Norway, Netherlands)	0.39%	1%

Empirical Evidence (III)

Bertschek et al (2011): broadband impact on firms' performance

- sample of 900 German firms over the period 2001-2003,
- no significant effect of broadband access on **labour productivity,** for this period.
- substantial impact on **innovation activity**.

- Firms that were **earlier adopters** of broadband were more likely to reshape their business processes and to develop new products and services.
- Not surprising: broadband effects on labour productivity might arise in the **long run**.
- To produce impacts broadband adoption must be accompanied by other investments in **complementary inputs**, such as organizational capital (*Brynjolfsson and Hit,* 2003)

Welfare Impacts of Gigabit Broadand

So far we have very **incipient research** on the economic impact of the deployment of super-fast and gigabit connections.

According to Sosa (2014):

- **Gigabit sceptics** argument that
  - the expected incremental benefits of the next generation networks may be **too optimistic** and
  - there appears to be a **declining return** to additional bandwidth.
- **Gigabit advocates** defend that
  - gigabit broadband will allow the development of **high-value applications** which cannot be delivered in any other way
  - additional bandwith carries **considerable returns**.

How to Measure Welfare Impacts?

Economic welfare impacts can be measured using some metrics like effects on **consumer surplus**, on **employment** and on **GDP**.

Some difficulties arise in this analysis:

1. How to identify and quantify all the **potential spillover effects** generated from the availability of super-fast connectivity:
   - Economic benefits might be under-estimated because the analysis ignores **network externalities**.

1. **Dynamic effects**: long term impacts are expected to be substantially more important than short-term impacts due to **technological innovation** and development of **new applications**

1. Potential Spillover Effects

High speed connectivity allows firms to **re-organize their production** processes obtaining substantial **cost savings**.

Examples: (Enck and Reynolds 2009):

i. Some companies place internal divisions in **different geographic locations** optimizing their factor needs.

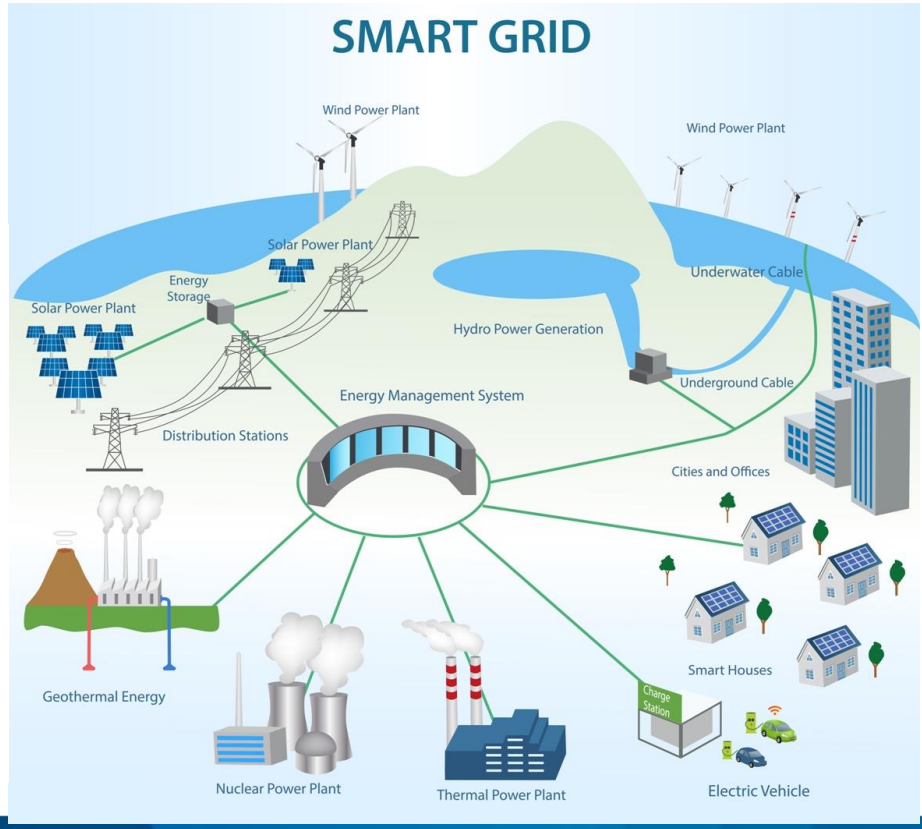
ii. Corporations with large **data storage requirements** can build **data centres** close to inexpensive renewable energy sources, in remote areas, to reduce energy costs.

iii. Teleworking: employees can work from home and still access to company resources.

1. Potential Spillover Effects

Almost all sectors in the economy benefit from high-speed connectivity. In particular:

1. **Electricity**: smart grids collect real time data which can be analysed by utilities and consumers in order to better manage consumption.



1. Potential Spillover Effects

E-Health:

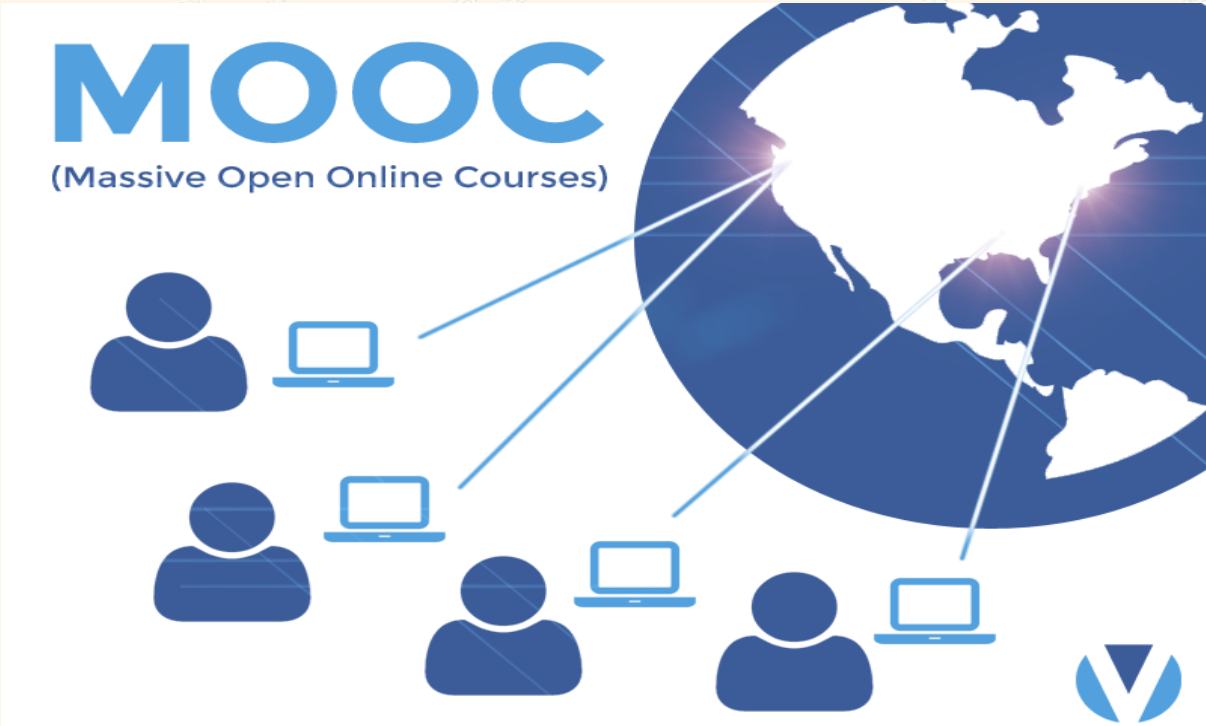
- digital versions of **medical exams** can be sent to other locations where they can be analysed by **remote specialists**.
- Innovative response to overwhelm **specialist shortage**, in particular in rural areas
- In telemedicine, some applications demand very **low latency** in order to safeguard efficiency and safety

1. Potential Spillover Effects

3. **Transports**:
   - gathering information that can help to reduce traffic congestion, lower fuel consumption, and help users to avoid accidents. **Intelligent Traffic Systems**
   - Public transports: inform users about cancellation and delays.

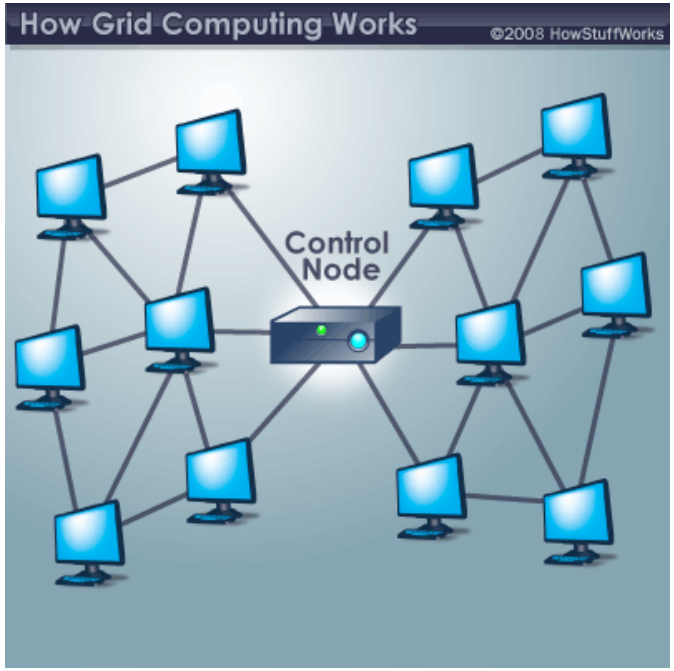
1. Potential Spillover Effects

4. **Education**: e-learning, improved by high speed connectivity that enabled videos usage
   MOOC courses provide high level knowledge to everyone everywhere

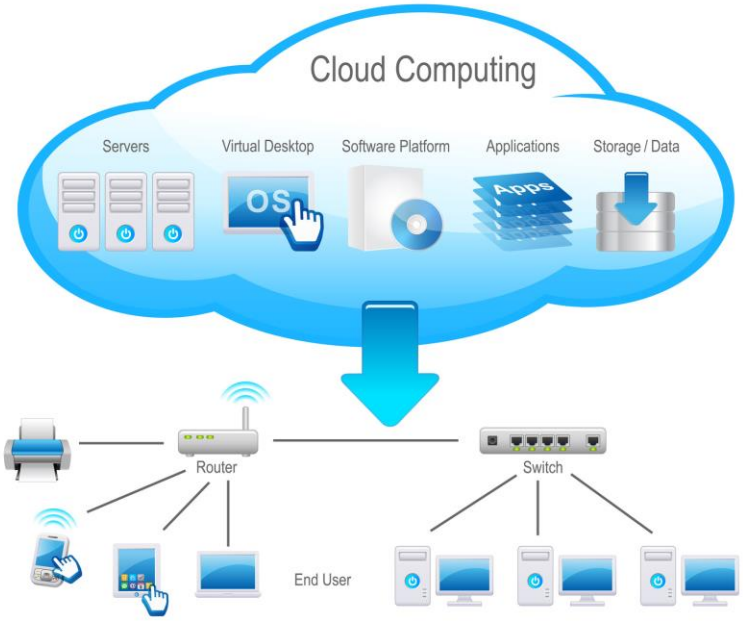


1. Potential Spillover Effects

5. **Grid computing**: efficient pooling of computer capacity to solve complex problems that are too large for individual computers

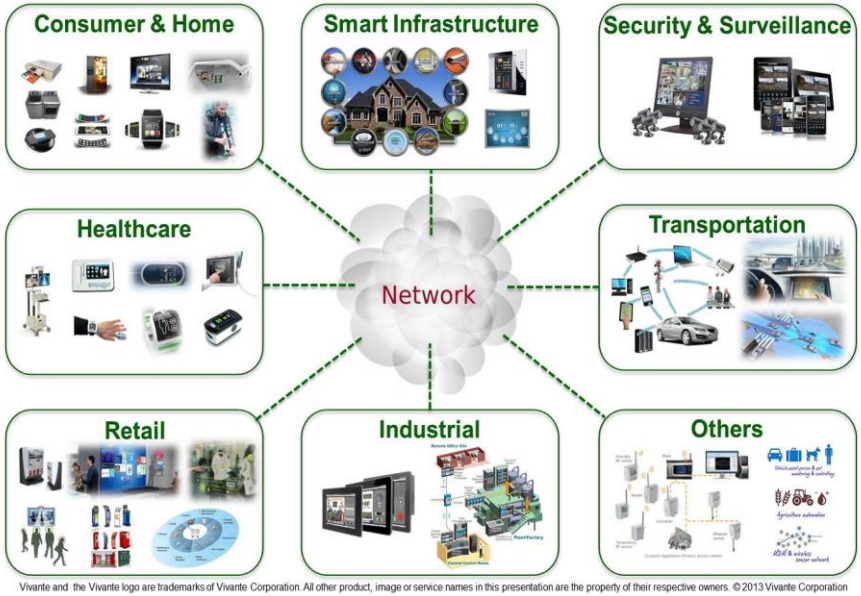


6. **Cloud computing**: : efficiently centralizes computing power and resources across internet: SMEs have access to computing resources according to their needs



1. Potential Spillover Effects

7. **Internet of Things** : high-speed networks enable the fast development of IoT that brings substantial costs savings.



8. **Artificial Intelligence**:

AI can be considered as a type of (intangible) capital.

Many of outputs of AI are intangible - is used as an input in making other capital rather consumption goods.

Difficult to measure!

New business models in the Gig Economy

Sharing Economy

"In the future we may own much less and share much more. And if we do, it will all be down to big data" Bernard Marr, Forbes, October 2016

High speed and **seamless connectivity** enabled new disruptive businesses that take advantage of the **massive data** available about people.

These companies are a new way to use **data analytics** effectively to provide services to people when and where they want them.

Big Data and **online platforms** are key ingredients to get scale.

New business models in the Gig Economy

FinTech: start-ups specialized in finance services.

- Disruptive models, based on **sophisticated technology**, are fast, dynamic and adopt a model that is based on **customer centricity**.
- Challenging the traditional banking sector's incumbents which are subject to **severe regulation** and a **costly legacy** due to heavy internal structures.
- Cryptocurrency, blockchain technology…

Revolut

monzo

Google Bank

How to measure the spillover effects?

These examples illustrate how hard it is to identify and to measure all the **indirect effects** in the economy growth (GDP) arising from the deployment of super-fast broadband.

In particular, the inability of markets to take into account **network externalities** and **social returns** of broadband connectivity can lead to **sub-optimal investment** since investors only care about market value and private returns.

On the **demand side**, it is also difficult to measure the impact on consumer surplus resulting from the intensive use of all online available apps and services at **almost no monetary cost** (social networks, information, media, entertainment).

2. Dynamic Effects

According to *Brynjolfsson & Rock* (2017), there is a **modern productivity paradox**: the new technologies have an incredible transformative potential that could increase productivity and economic welfare, however the **productivity growth** over the past decade has **slowed significantly**.

Annual aggregate labour productivity growth

	1995-2004	2005-2016
United States	2,8%	1,3%
28 OECD countries	2,3%	1,1%

Are these data confirming ***Solow* Paradox** (1987) "*we see transformative new technologies everywhere but in the productivity statistics*"?

2. Dynamic Effects

Brynjolfsson & Rock (2017) discard the "*inherent **inconsistency** between forward-looking technological optimism and backward-looking disappointment*": main argument is the **time lag** between the initial technology innovation and its full impact on the economy and society.

Two main sources of the delay:

1. It takes time for the **new technology to spread** and **get enough scale** to have an **aggregate effect**.
2. **Complementary processes** and **assets** are necessary to obtain the **full benefit** of the new technology and it takes time to discover, develop and implement them.

2. Dynamic Effects

Dynamic effects can help to understand some empirical findings, as *Briglauer and Gugler, (2018*) - panel dataset of EU27 members during 2003-2015:

*"we **could not identify clear evidence** that adoption of ultra-fast broadband provides substantially higher benefits than fast broadband."*

On the contrary*, Sosa (2014)* compares US regions where **gigabit broadband** (GB) services have recently become **widely available** with similarly sized regions where GB is not widely available.

Controlling for idiosyncratic differences across regions, over time, he found that **the per capita GDP is approximately 1.1% higher** in regions with GB.

Brave New World… but the costs?

- The new age of a Gigabit Society brings also some negative impacts on economic welfare:
  - Cybersecurity
  - Privacy and Data Protection
  - Automation (AI) and polarization of the labor market
  - Fake news

Conclusions

- We are still in the **infancy** of the gigabit society
- Most of the benefits on economic welfare of super-fast networks **will take years to fully manifest**.
- The impacts of *Internet of Things*, *Artificial Intelligence*, *Industry 4.0*, etc. are just in their initial steps and very far away from their **full potential impact** on the economy and on the society.
- Given the complexity of the new reality economists need to **update economic measurement toolkits** .

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