

Developing a “National Broadband Strategy”:
Understanding the OECD Data and Drivers of
Broadband Adoption



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Presumption



The U.S. has fallen behind on broadband penetration, ...

(pcworld.com, 07/24/2008)

What's the Real Question?

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If you say the U.S. is lagging in broadband subscription, then you are saying the U.S. has a subscription rate below what it 'should' be.

What 'should' it be?

What is a reasonable expectation of subscription relative to other OECD countries?

OECD Rank

(Broadband Connections, Dec. 2007)



#	Name	BB Subs	#	Name	BB Subs	#	Name	BB Subs
1	United States	69,859,707	11	Australia	4,830,200	21	Portugal	1,524,675
2	Japan	28,302,152	12	Mexico	4,548,838	22	Czech Republic	1,501,420
3	Germany	19,579,000	13	Turkey	4,395,800	23	Norway	1,455,000
4	United Kingdom	15,606,100	14	Poland	3,340,000	24	Hungary	1,365,650
5	France	15,550,000	15	Sweden	2,755,014	25	Greece	1,017,475
6	Korea	14,709,998	16	Belgium	2,715,308	26	Ireland	767,800
7	Italy	10,122,126	17	Switzerland	2,340,650	27	New Zealand	757,132
8	Canada	8,675,197	18	Denmark	1,906,557	28	Slovak Rep.	412,012
9	Spain	7,951,905	19	Austria	1,622,023	29	Luxembourg	126,360
10	Netherlands	5,682,770	20	Finland	1,617,100	30	Iceland	97,937

The U.S. has more than twice the number of connections as any other OECD country.

Now, George, Wait a Minute!



The U.S. is the largest country in the OECD, in many dimensions. In fact, it is more than twice as large in terms of population than any other OECD country.

OECD Rank

(Broadband Connections of the Type Counted/Population/100, Dec. 2007)



#	Name	BB Subs	#	Name	BB Subs	#	Name	BB Subs
1	Denmark	35.1	11	United Kingdom	25.8	21	Spain	18.0
2	Netherlands	34.8	12	Belgium	25.7	22	Italy	17.2
3	Iceland	32.2	13	France	24.6	23	Czech Republic	14.6
4	Norway	31.2	14	Germany	23.8	24	Portugal	14.4
5	Switzerland	31.0	15	United States	23.3	25	Hungary	13.6
6	Finland	30.7	16	Australia	23.3	26	Greece	9.1
7	Korea	30.5	17	Japan	22.1	27	Poland	8.8
8	Sweden	30.3	18	Austria	19.6	28	Slovak Republic	7.6
9	Luxembourg	26.7	19	New Zealand	18.3	29	Turkey	6.0
10	Canada	26.6	20	Ireland	18.1	30	Mexico	4.3

Ah-Hah! Once conditioned on population, the U.S. ranks 15th.

Conditioning on Population

- Normalization (or conditioning) on “size” makes some sense.
 - But, normalizing subscriptions by population is not an innocuous calculation.
 - We could normalize by other things, and get different results.
 - This is an important issue, but not the most important issue.
- **Country A**
 - 100 homes
 - 2.5 people per home
 - 250 people
 - **Country B**
 - 100 homes
 - 2 people per home
 - 200 people
 - **Half homes have broadband**
 - A: $\text{Sub/Pop} = 0.20$
 - B: $\text{Sub/Pop} = 0.25$
 - Identical, but appear different due to differences in household size.

Conditioning on Population

- **United States**
 - 2.7 people/home
 - **Sweden**
 - 2.0 people/home
 - U.S. has to have 35% more connections than Sweden just to make up for the household size difference
 - Matching household size, U.S. would rank about 4th
- **United States**
 - 2.7 people/home
 - **Denmark**
 - 2.2 people/home
 - U.S. has to 23% more connections that Denmark just to make up for household size difference
 - Matching household size, U.S. would rank about 9th

Conditioning on Households

- Households may be better, but even this option ignores that (some) business lines are counted.
- OECD data does not differentiate between business and residential lines.
- Country A
 - 100 homes, 10 businesses
 - 250 people
- Country B
 - 100 homes, 20 businesses
 - 250 people
- Half homes, All businesses have broadband
 - A: $\text{Sub/Pop} = 0.23$
 - B: $\text{Sub/Pop} = 0.25$
- Identical, but again appear different due to difference in number (or size) of businesses

Broadband Nirvana:

All Homes and Business Have Broadband



Country	Subscription	Rank	Country	Subscription	Rank
Sweden	0.541	1	New Zealand	0.398	16
Iceland	0.489	2	Portugal	0.392	17
Czech Republic	0.478	3	Japan	0.39	18
Denmark	0.478	4	United Kingdom	0.389	19
Finland	0.477	5	United States	0.38	20
Germany	0.449	6	Luxembourg	0.378	21
Netherlands	0.437	7	Greece	0.362	22
Switzerland	0.429	8	Slovak Republic	0.351	23
France	0.424	9	Ireland	0.347	24
Canada	0.419	10	Poland	0.341	25
Hungary	0.411	11	Spain	0.338	26
Belgium	0.41	12	Australia	0.315	27
Austria	0.406	13	Korea	0.254	28
Italy	0.404	14	Mexico	0.247	29
Norway	0.403	15	Turkey	0.212	30

Rank is Ordinal



I Can Rank This ...

1. 36.6
2. 35.9
3. 24.5
4. 23.1
5. 15.2

And, I Can Rank This ...

1. 36.60
2. 36.59
3. 36.58
4. 36.57
5. 36.56

Conditioning on Other Factors



- **Mexico and Turkey rank low, but we are not surprised – they are relatively poor and uneducated countries.**
- **Broadband is a service.**
 - It has a demand.
 - It has a supply.
 - Subscription is not determined by government choice, or by national pride.
 - How do supply side/demand side conditions vary across markets?

Forming Expectations



Is history a guide?

Trends in OECD Rank: The Fall

(Connections/Capita)



2001	2002	2003	2004	2005	2006	2007
Korea	Korea	Korea	Korea	Iceland	Denmark	Denmark
Canada	Canada	Canada	Denmark	Korea	Netherlands	Netherlands
Sweden	Belgium	Iceland	Netherlands	Netherlands	Iceland	Iceland
U.S.	Iceland	Denmark	Iceland	Denmark	Korea	Norway
	Demark	Netherlands	Canada	Switzerland	Switzerland	Switzerland
	Sweden	Belgium	Switzerland	Finland	Norway	Finland
	Netherlands	Sweden	Belgium	Norway	Finland	Korea
	U.S.	Japan	Japan	Canada	Sweden	Sweden
		Switzerland	Finland	Sweden	Canada	Luxembourg
		U.S.	Norway	Belgium	Belgium	Canada
			Sweden	Japan	UK	United Kingdom
			U.S.	UK	Luxembourg	Belgium
				U.S.	France	France
					Japan	Germany
					U.S.	U.S.



Trends in OECD Rank: The Rise (Connections/Capita)



2001	2002	2003	2004	2005	2006	2007
Korea	Korea	Korea	Korea	Iceland	Denmark	Denmark
Canada	Canada	Canada	Denmark	Korea	Netherlands	Netherlands
Sweden	Belgium	Iceland	Netherlands	Netherlands	Iceland	Iceland
U.S.	Iceland	Denmark	Iceland	Denmark	Korea	Norway
	Denmark	Netherlands	Canada	Switzerland	Switzerland	Switzerland
	Sweden	Belgium	Switzerland	Finland	Norway	Finland
	Netherlands	Sweden	Belgium	Norway	Finland	Korea
	U.S.	Japan	Japan	Canada	Sweden	Sweden
		Switzerland	Finland	Sweden	Canada	Luxembourg
		U.S.	Norway	Belgium	Belgium	Canada
			Sweden	Japan	UK	United Kingdom
			U.S.	UK	Luxembourg	Belgium
				U.S.	France	France
					Japan	Germany
					U.S.	U.S.

OECD Rank

(Fixed Telephones 2000 (Maturity); Broadband Dec 2007)



Name	BB #	TEL #		Name	BB #	TEL #		Name	BB #	TEL #	
Denmark	1	3	2	United Kingdom	11	8	-3	Spain	21	22	1
Netherlands	2	12	10	Belgium	12	18	6	Italy	22	20	-2
Iceland	3	6	3	France	13	16	3	Czech Republic	23	24	1
Norway	4	10	6	Germany	14	14	0	Portugal	24	25	1
Switzerland	5	5	0	United States	15	15	0	Hungary	25	26	1
Finland	6	4	-2	Australia	16	11	-5	Greece	26	9	-17
Korea	7	17	10	Japan	17	13	-4	Poland	27	28	1
Sweden	8	1	-7	Austria	18	21	3	Slovak Republic	28	27	-1
Luxembourg	9	7	-2	New Zealand	19	19	0	Turkey	29	29	0
Canada	10	2	-8	Ireland	20	23	3	Mexico	30	30	0

Broadband rankings are remarkably similar to telephone rankings when telephones were at maturity.

Convergence to Terminal Position?



BB/Cap

30.0
25.0
20.0
15.0
10.0
5.0
0.0

Year 2000

UK (BB = 21, TEL = 10)

Germany (BB = 17, TEL = 14)

US (BB = 3, TEL = 15)

Italy (BB = 19, TEL = 20)

UK (BB = 11, TEL = 10)

Germany (BB = 14, TEL = 14)

US (BB = 15, TEL = 15)

Italy (BB = 22, TEL = 20)

2001-Q4
2002-Q2
2002-Q4
2003-Q2
2003-Q4
2004-Q2
2004-Q4
2005-Q2
2005-Q4
2006-Q2
2006-Q4
2007-Q2
2007-Q4



Forming an Expectation

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- ✓ How does population compare?
- ✓ How does household size compare?
- ✓ How does income compare?
- ✓ How does income inequality compare?
- ✓ How does education attainment compare?
- ✓ How does age compare?
- ✓ How does broadband price compare?

These are the thoughts that drive our expectations.

Expectations



$$\text{BB/POP} = f(\text{Price, Income, Inequality, Education, Age, Density, Etc})$$

Some function f that translates endowments into broadband. We can use this function to get an expected broadband subscription rate.

Performance/Efficiency: The difference between “what is” and “what is expected.”

Conversion of Endowments



- From a large dataset, we compute that, on average, \$1000 of income converts to 1 unit of broadband demand.
 - \$10,000 income, 10 units of broadband demand
 - \$20,000 income, 20 units of broadband demand
- **Country A.**
 - \$20,000 income, 25 units of observed demand
 - Country A is doing better than expected
- **Country B**
 - \$20,000 income, 15 units of observed demand
 - Country B is doing worse than expected

Two Empirical Approaches

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Least Squares Approach:

$$\ln B_i = \beta_0 + \sum_{j=1}^k \beta_j \ln X_j + v_i$$

$$BPI = \hat{v}_i / \max(|\hat{v}_i|)$$

Stochastic Frontier Analysis:

$$\ln B_i = \beta_0 + \sum_{j=1}^k \beta_j \ln X_j + v_i - u_i$$

$$BEI = \exp(-u_i)$$

Data

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- **3 Semesters of subscription data (90 Observations)**
- **Regressors:**
 - PRICE (“average” price for broadband)
 - GDP per capita (income)
 - GINI Coefficient (income inequality)
 - EDUC (% tertiary education)
 - AGE65 (% over 65)
 - DENSITY (population/km²)
 - BIGCITY (% pop in biggest city)
 - PHONE (telephones/population; demand for traditional communications services)
 - HHSIZE (population/households)
 - BUSSIZE (population/business establishments)
 - Period dummies

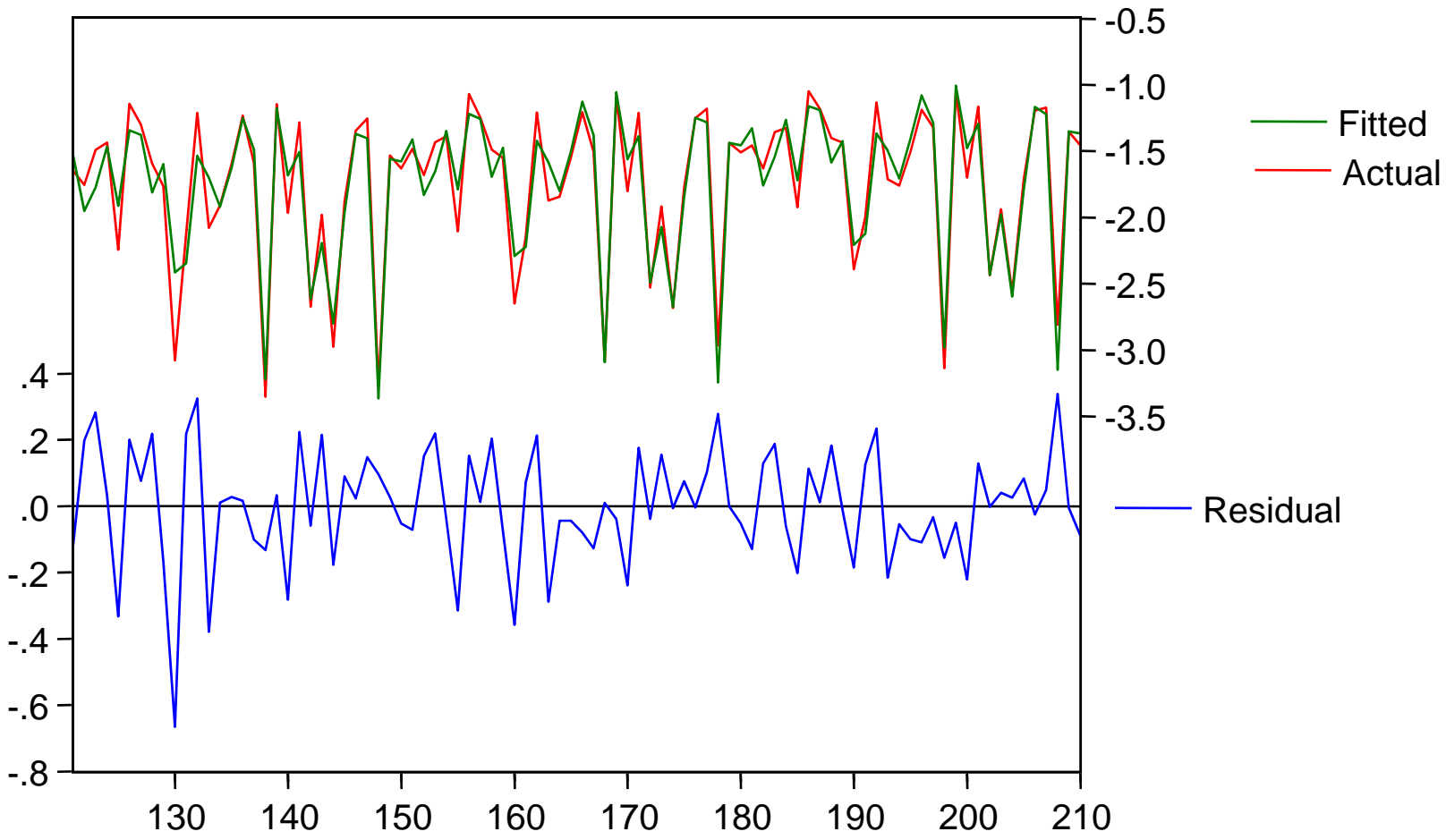
Results

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- $R^2 = 0.91$
- All regressors statistically significant
- Marginal Effects (elasticities; least squares)
 - PHONE +2.0
 - GINI -1.2
 - GDPCAP +0.58
 - AGE65 -0.55
 - PRICE -0.39
 - HHSIZE +0.35
 - BUSSIZE -0.23
 - EDUC +0.20
 - BIGCITY -0.20
 - DENSITY +0.03

Predictions:

91% of Variation in Subscriptions Explained



Efficiency Measure from SFA:

Broadband Efficiency Index

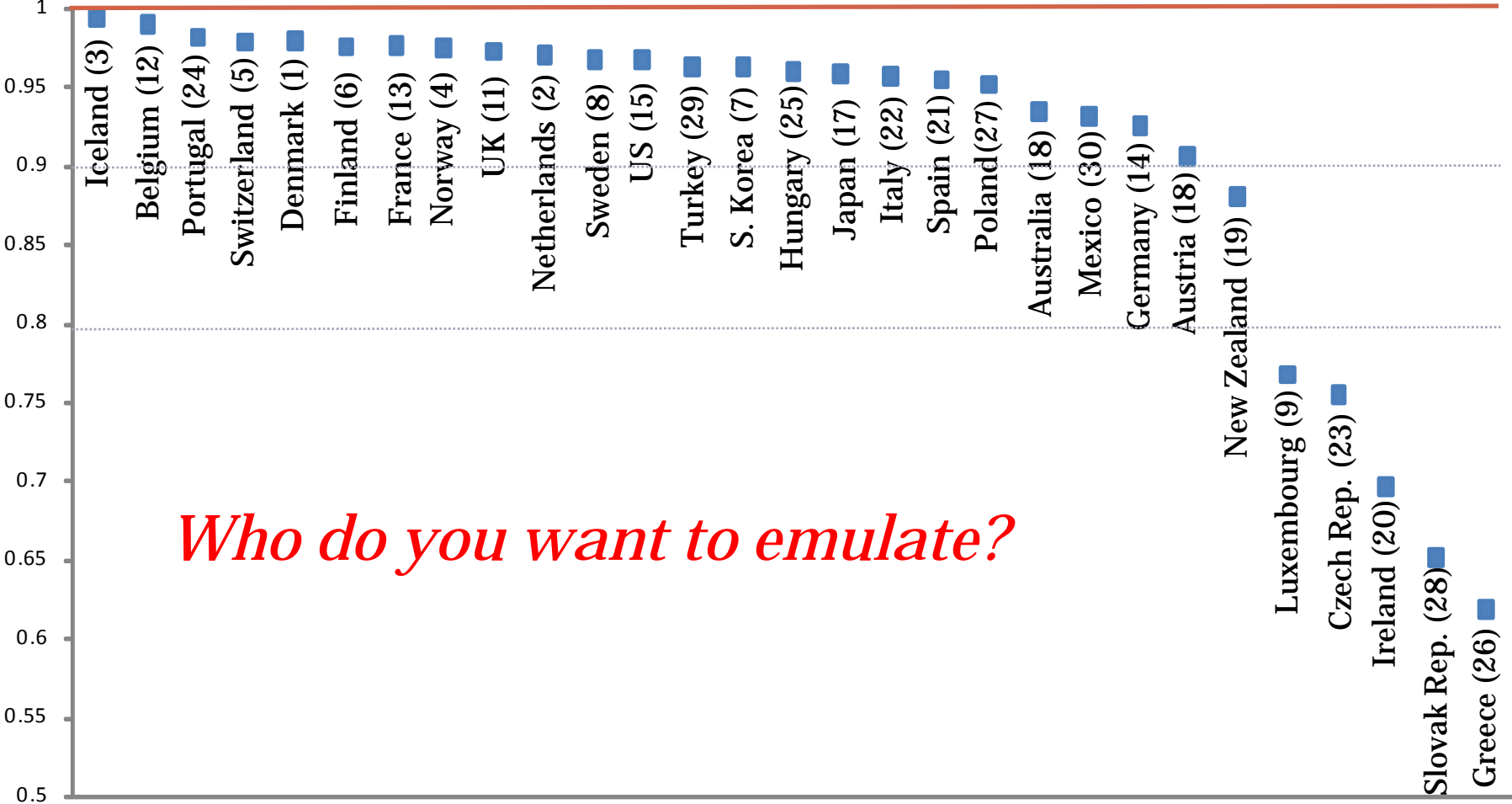
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Country	BEI		Country	BEI		Country	BEI
Iceland (3)	0.995		Netherlands (2)	0.970		Australia (16)	0.934
Belgium (12)	0.990		Sweden (8)	0.967		Mexico (30)	0.931
Portugal (24)	0.983		US (15)	0.967		Germany (14)	0.925
Switzerland (5)	0.980		Turkey (29)	0.963		Austria (18)	0.906
Denmark (1)	0.979		S. Korea (7)	0.963		New Zealand (19)	0.880
Finland (6)	0.977		Hungary (25)	0.960		Luxembourg (9)	0.769
France (13)	0.976		Japan (17)	0.958		Czech Rep. (23)	0.755
Norway (4)	0.975		Italy (22)	0.957		Ireland (20)	0.696
UK (11)	0.974		Spain (21)	0.956		Slovak Rep. (28)	0.651
Canada (10)	0.972		Poland (27)	0.953		Greece (26)	0.619

Technical Efficiency



THE FRONTIER



Who do you want to emulate?

Comparison of Actual and Frontier Rank

(Everybody does the best they can – sort of)

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Country	Actual Rank 12/07	Front. Rank 12/07		Country	Actual Rank 12/07	Front. Rank 12/07		Country	Actual Rank 12/07	Front. Rank 12/07	
Australia	16	11	+5	Hungary	25	27	-2	Norway	4	8	-4
Austria	18	15	+3	Iceland	3	22	-19	Poland	27	28	-1
Belgium	12	20	-8	Ireland	20	5	+15	Portugal	24	26	-2
Canada	10	10	0	Italy	22	23	-1	Slovak	28	25	+3
Czech Rep.	23	16	+7	Japan	17	14	+3	Spain	21	21	0
Denmark	1	3	-2	Korea	7	4	+3	Sweden	8	6	+2
Finland	6	9	-3	Luxem	9	1	+8	Switz	5	7	-2
France	13	18	-5	Mexico	30	29	+1	Turkey	29	30	-1
Germany	14	12	+2	Netherl	2	2	0	UK	11	13	-2
Greece	26	24	+2	New Zeal	19	19	0	US	15	17	-2

Improvements in Efficiency

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Country	Improvement
Greece	1.673
Slovak Republic	1.279
Ireland	1.217
Luxembourg	1.117
New Zealand	1.114
Czech Republic	1.105
Germany	1.099
Turkey	1.073
Australia	1.047
Poland	1.027

Policy Implications



- A rank of 15th is really not an indicator of the health of our broadband sector
- We are doing pretty well, actually, given our relative set of endowments
- Ranking of raw subscription numbers is meaningless when assessing the relative performance of countries with regard to broadband infrastructure and use
- These conclusions do not suggest broadband deployment and subscription can't be improved in this country, or that we shouldn't try, but we are "falling behind" or "laggards" in any real sense of the term.
- In fact, the evidence supports the U.S.'s leadership on broadband (the others are playing catch up to get in their right position)

Convergence to Terminal Position?



BB/Cap

30.0
25.0
20.0
15.0
10.0
5.0
0.0

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2004-Q4
2005-Q2
2005-Q4
2006-Q2
2006-Q4
2007-Q2
2007-Q4



Do You Want a Bigger Number?



Broadband is a Service

- It is demanded by consumers
- It is supplied by firms

Want More

- Increase Demand
 - BB is bought when its $VALUE > PRICE$, when it's available
- Increase Supply
 - It becomes cheaper or more profitable to sell it

Basic Policy Filter



- **Does this policy make change consumer valuation of broadband service or change the price?**
 - You want higher value
 - You want lower price
 - Example: Retail Tiering – reduces prices to the marginal customer, expanding consumption
- **At the same time, does it change the cost of providing broadband service or change the profits of selling it?**
 - You want lower cost
 - You want higher profit (under a competitive constraint) for deployment (e.g. lower taxes; tax credits; accelerated depreciation)
 - Example. Net Neutrality increases costs, reduces profits, and will reduce deployment
 - Example. Interconnection. Unlevel playing field on interconnection discourages broadband deployment

Supply Side

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- **Assuming 10% unavailability, our rank would increase 4 spots (Rank 11th) if we resolved this shortfall**
- **Improve finances of deployment**
 - Tax credits
 - Accelerated depreciation
 - Subsidies (fix RUS)
 - Less regulation
 - Video franchising
- **Supply Coordination**
 - Connect Kentucky; Connected Nation
- **Eliminate Rent Extraction by Local Government**
 - In Japan, cities subsidize deployment, rather than require free services

Demand Side



- **Education programs**
- **Demand-side Coordination**
- **Computer ownership programs**
 - Connected Nation – “No Child Left Offline”
- **Schools**
 - Computer use in school promotes use at home; lagged effect

Investments in Speed/Bandwidth



“It is not the multitude of alehouses ... that occasions a general disposition to drunkenness among the common people; but that disposition, arising from other causes, necessarily gives employment to a multitude of alehouses.”

Adam Smith, *Wealth of Nations* (1776)

Harmony in Policy

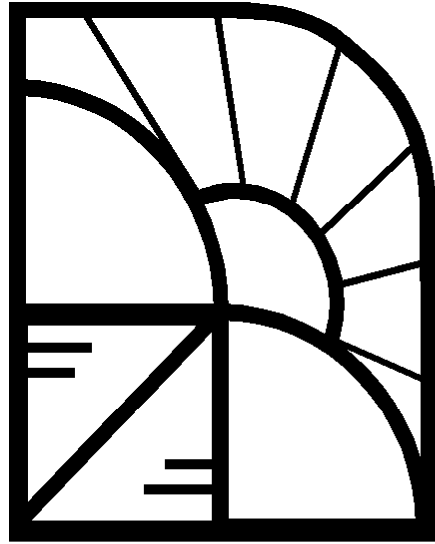


What are the Pareto Improving Policies?

How can we make consumers better off without hurting sellers?

How do we make sellers better off without hurting consumers?

How do we make everyone better off?



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