Evaluating Broadband Adoption

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We are interested in broadband because it has value, not because it can be counted.

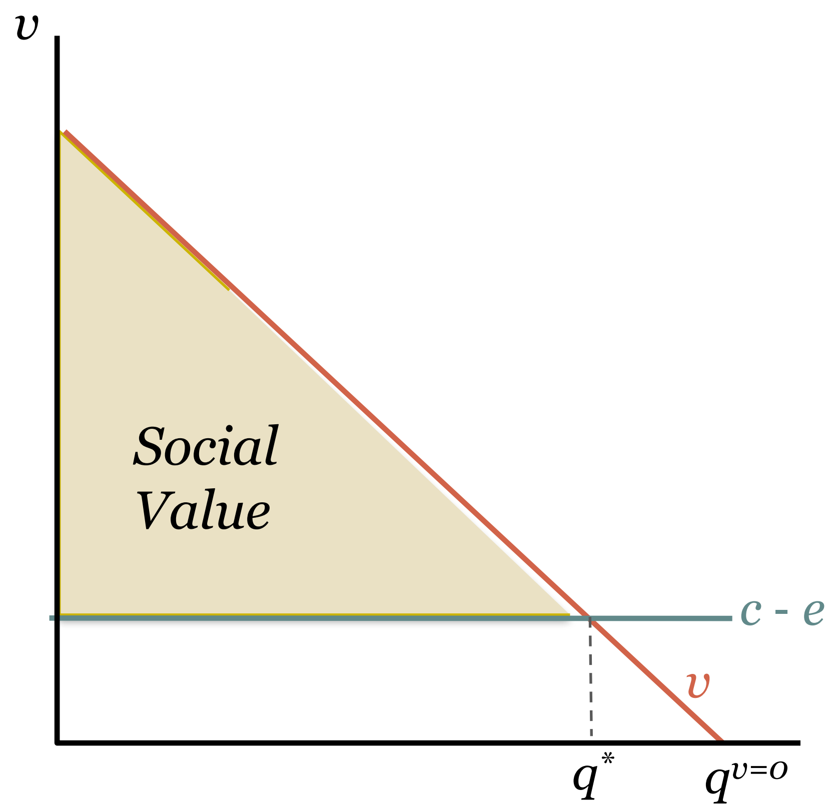
But common measures of broadband adoption have nothing to do with value, but are pure counts (normalized).

What is the value of broadband?

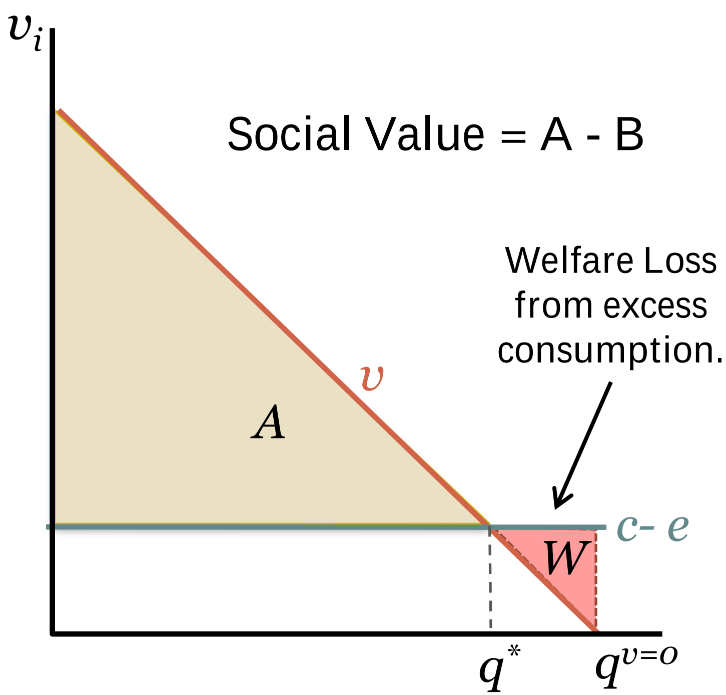
For any user i, it is the Willingness to Pay, plus any social premia (externalities, spillovers, etc.), less the social cost of production.

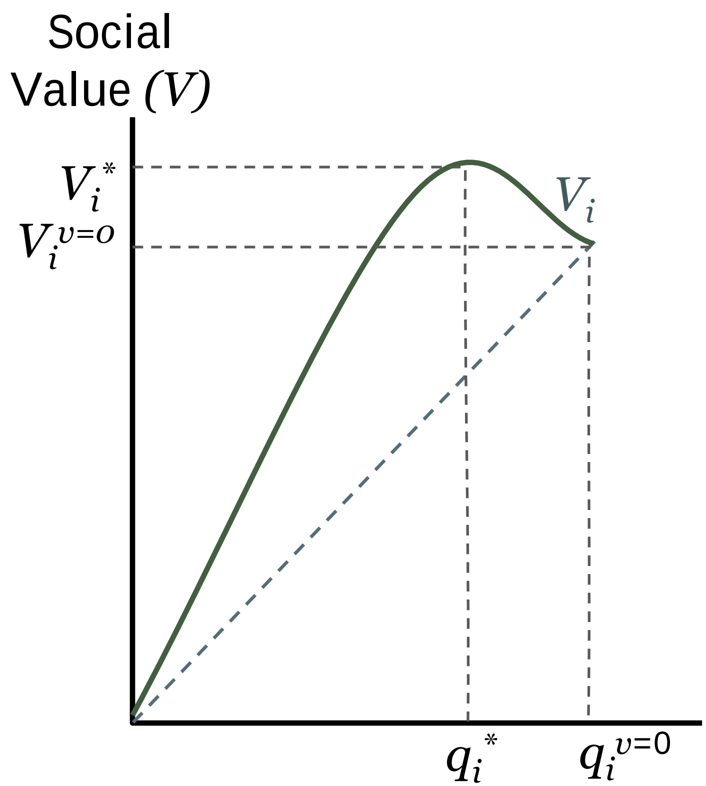
For society, it is the sum of all these individual values.

Simple Graph



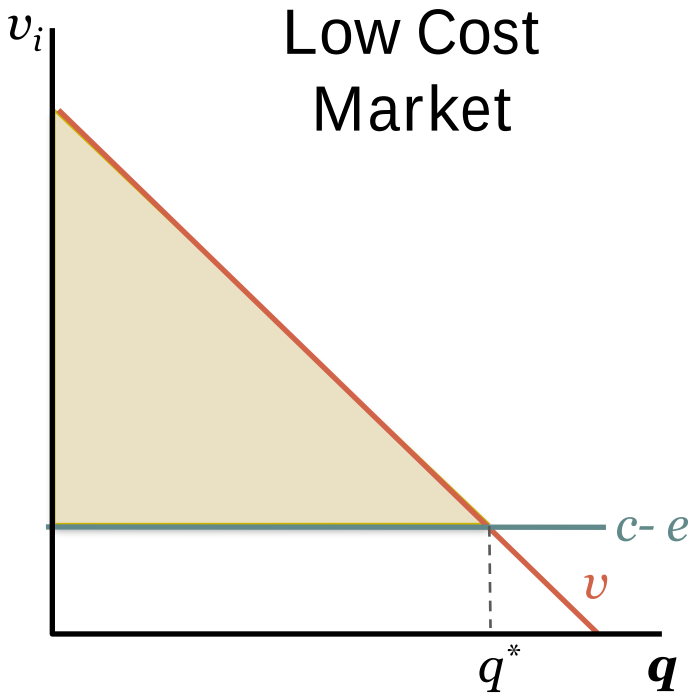
Maximum Subscription is Not Ideal

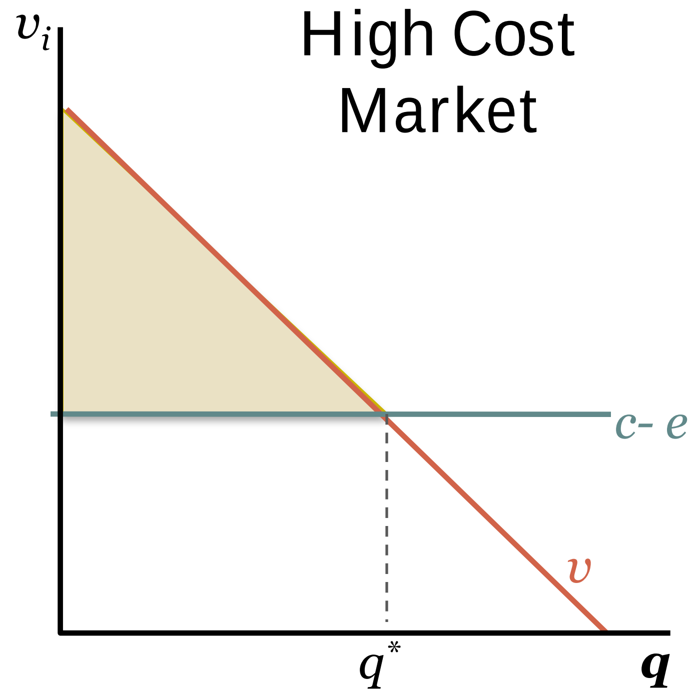




As long as c - e > 0, 100% consumption is not ideal.

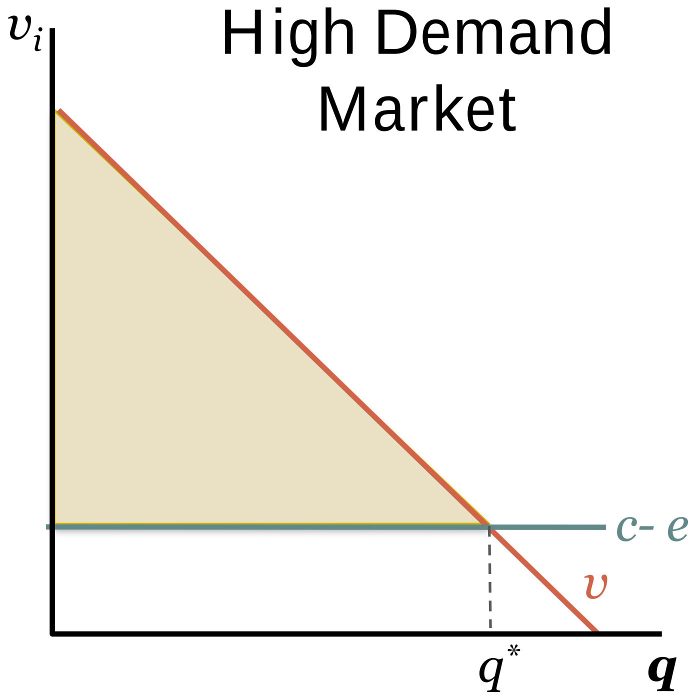
Optimal Consumption Depends on Costs

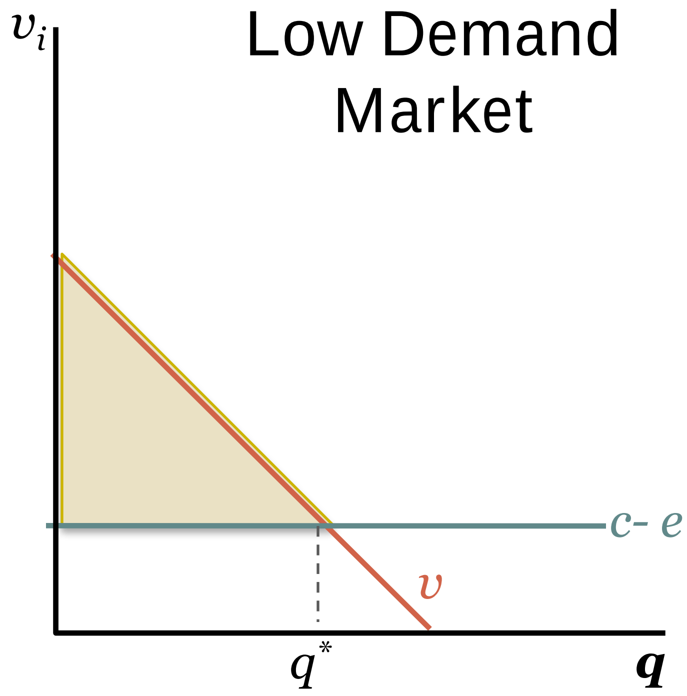




If costs are higher, then optimal quantity is lower.

Optimal Consumption Depends on Demand



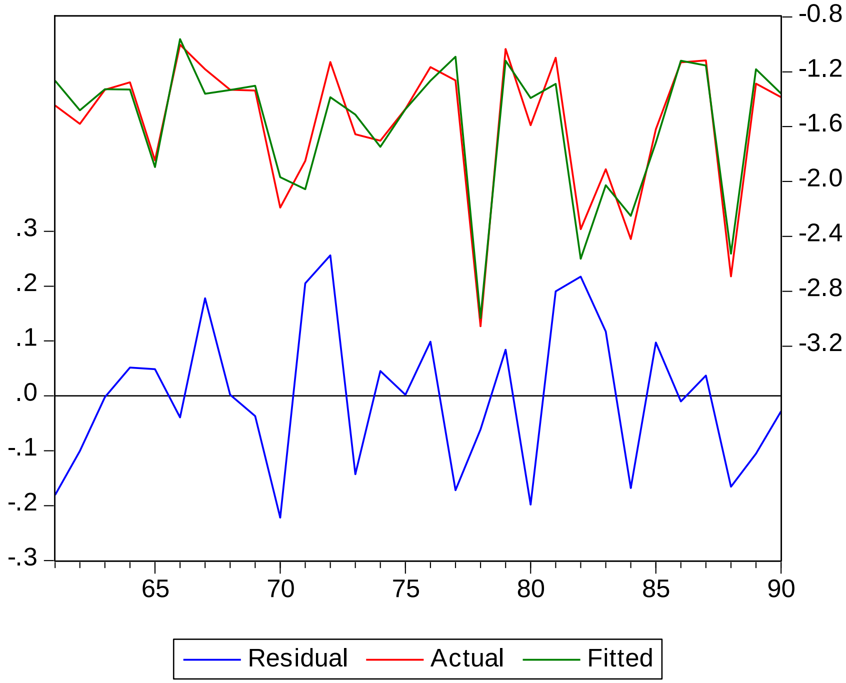


If demand is lower, then optimal quantity is lower.

Value is Different Across Countries

Variable	Coef	t-stat
C	-9.95	-4.81
LN(PRICE)	-0.39	-2.56
LN(GDPCAP)	0.35	2.46
LN(GINI)	-0.73	-3.18
LN(AGE65)	-0.29	-2.60
LN(URBAN)	0.99	3.89
LN(TEL)	2.81	3.50
LN(TEL)^2	-0.36	-2.73

N = 30; June-08 data; R^2 = 0.93



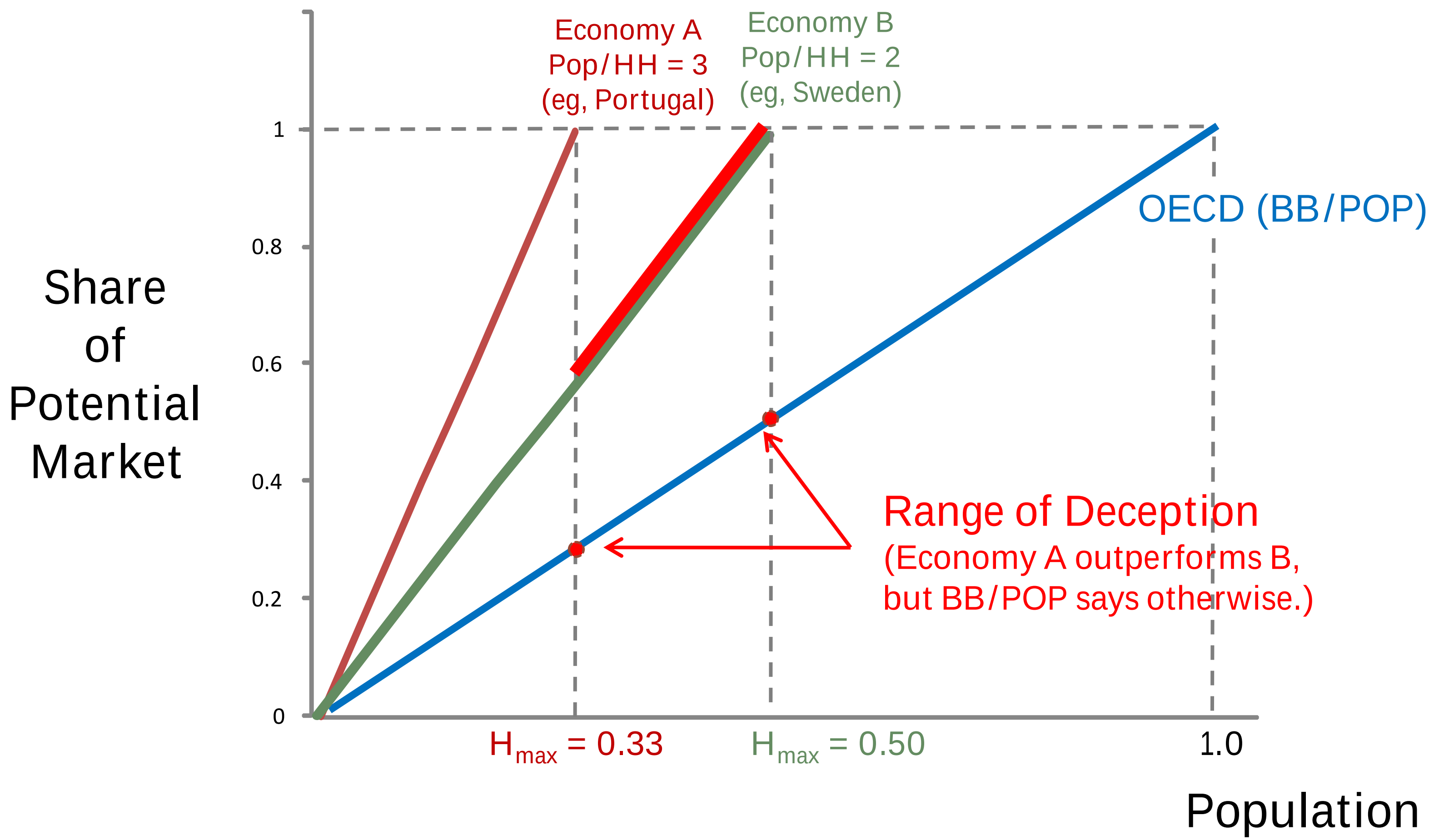
Nearly all (93%) of the differences in fixed connections per capita across countries are explained by few demographic and economic endowments.

Thanks for the course in
economic principles, but …

So what?

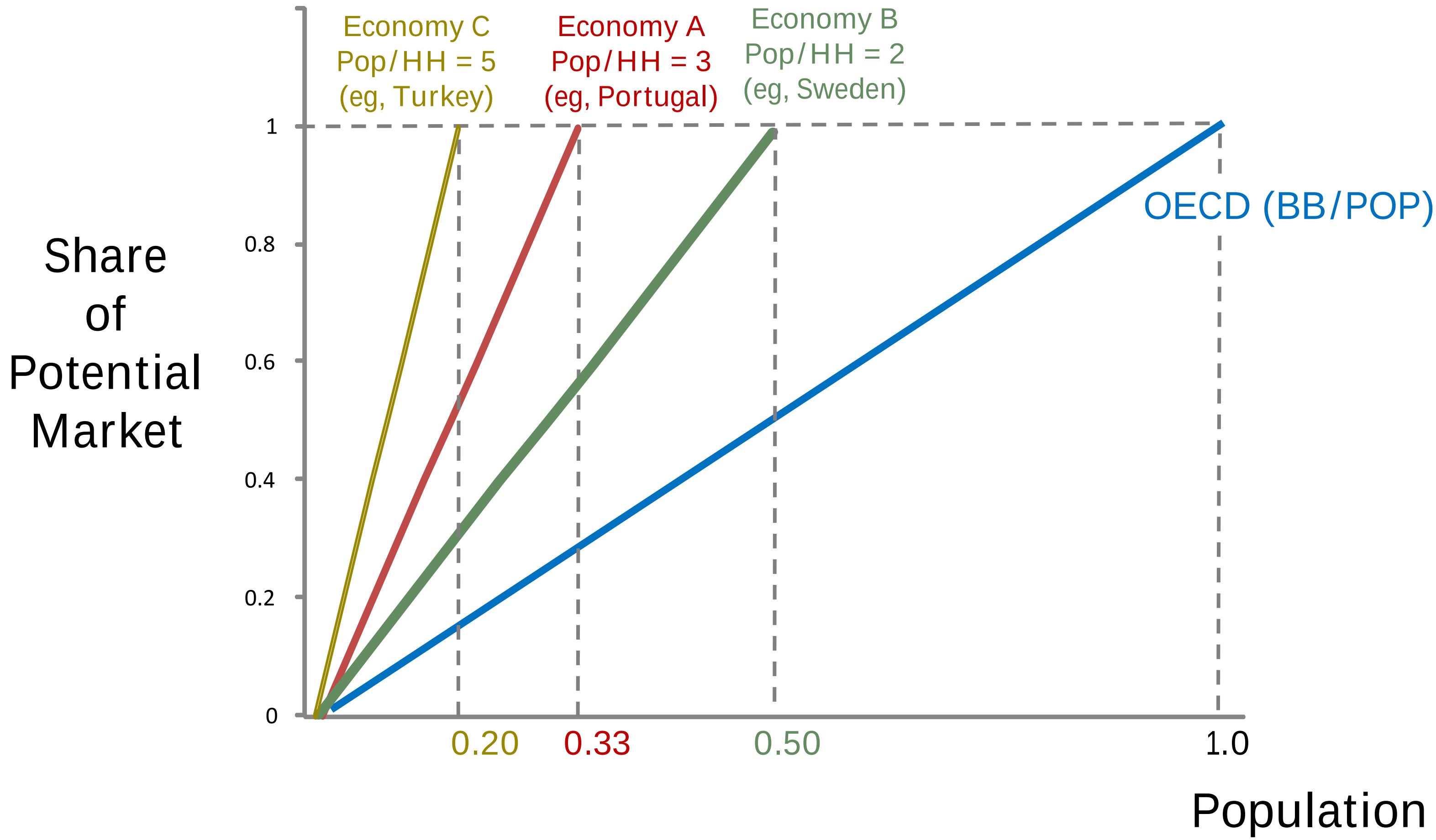
Nothing in the per-capita normalization of connections counts has anything to do with this. The current measure of adoption is void of economic meaning.

BB/POP tells you NOTHING



Ignores business connections (could assume proportional to households and scale up; no loss of generality).

BB/POP tells you NOTHING



Evidence

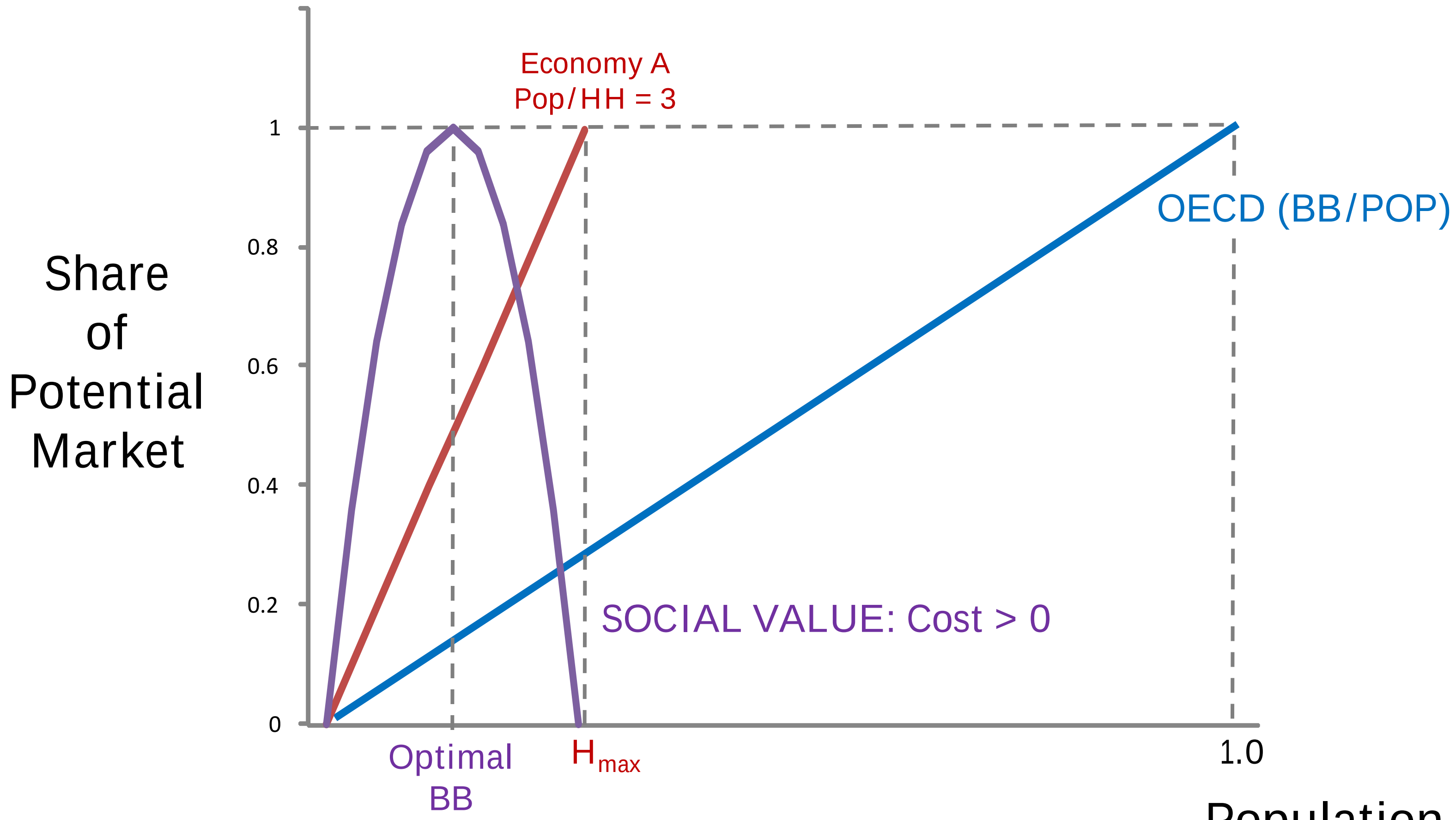
Telephones per capita (1996):

Sweden 0.686

U.S. 0.493

(*A difference without a difference*)

Broadband: No Free Lunch



Dividing by households is better, but does not solve the problem.

Dividing by Telephones/Capita is better yet, but still does not solve the problem.

How do you create in a single index of performance heterogeneous connections modalities (Fiber, Coax, DSL, Mobile, Wi-Fi, Nomadic, Dialup)?

Presumably the demand, costs, and social premia differ for each modality, for each country, and for regions within a country.

We require a properly scaled, value-based measured of broadband adoption.

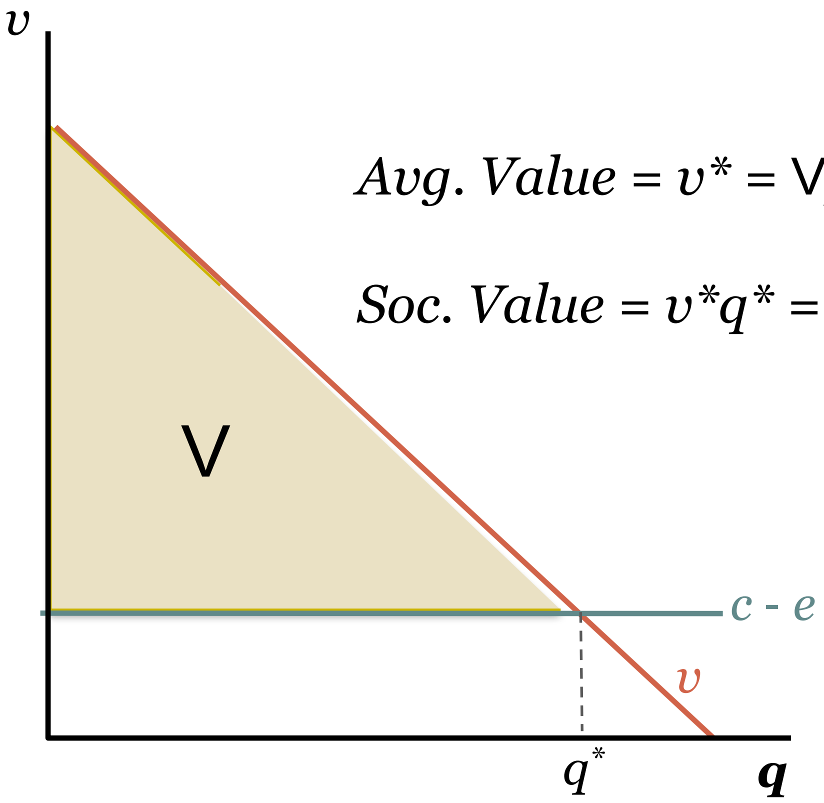
Broadband Adoption Index

$$BAI_t = \frac{\text{Actual}_t}{\text{Target}}$$

Goal:

1. Provide for meaningful performance evaluation across geo-political units (intra- and internationally).
2. Incorporate the underlying economics of adoption and deployment
3. Accommodate different connection modalities

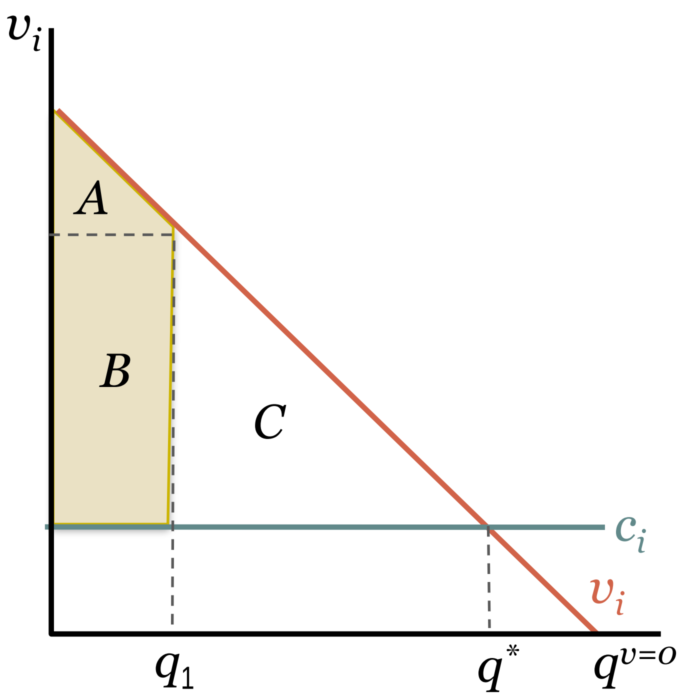
Simple Graph



Avg. Value = v^* = V/q^*

Soc. Value = v^*q^* = V

BAI at Time *t*



$$\bar{v}_1 = (A + B) / q_1$$

$$A_t = \frac{\bar{v}_1 q_1}{v^* q^*}$$

$$A_t = \frac{A + B}{A + B + C}$$

Assumption: Marginal, thus average, valuation declines over time. Here, highest valued users adopt first.

Multiple Modalities

$$\text{Actual}_t = \sum_{i=1}^{N} \overline{v}_{i,t} \cdot q_{i,t}$$

q_i = quantity of connections of modality i at time t
v_i = average value of a connection of modality i at time t (consumer surplus + profit, or economic welfare)

$$\text{Target} = \sum_{i=1}^{N} v_i^* \cdot q_i^*$$

v_i^* = average social value of a connection of modality i at the "target"
q_i^* = quantity of connections of modality i at the "target"

Three Modalities (f, m, k)

$$BAI_t = \frac{\bar{v}_{f,t} \cdot q_{f,t} + \bar{v}_{m,t} \cdot q_{m,t} + \bar{v}_{k,t} \cdot q_{k,t}}{v_f^* \cdot q_f^* + v_m^* \cdot q_m^* + v_k^* \cdot q_k^*}$$

Does it simplify?

One Modality

$$BAI_t = \frac{\overline{v}_{f,t} \cdot q_{f,t}}{v_f^* \cdot q_f^*} = \frac{\lambda v_f^* \cdot q_{f,t}}{v_f^* \cdot q_f^*} = \frac{\lambda q_{f,t}}{q_f^*}$$

v_i^* = average social value of a connection of modality i at the "target"
q_i^* = quantity of connections of modality i at the "target"

Two Modalities (f, m)

$$BAI_t = \frac{\lambda v_f^* \cdot q_{f,t} + \lambda\phi v_m^* \cdot q_{m,t}}{v_f^* \cdot q_f^* + \phi v_m^* \cdot q_m^*} = \frac{\lambda(q_{f,t} + \phi q_{m,t})}{q_f^* + \phi q_m^*}$$

This clearly illustrates the problem with quantity-based measures.

Query: Should OECD report counts and stop scaling?

Initial Simulation

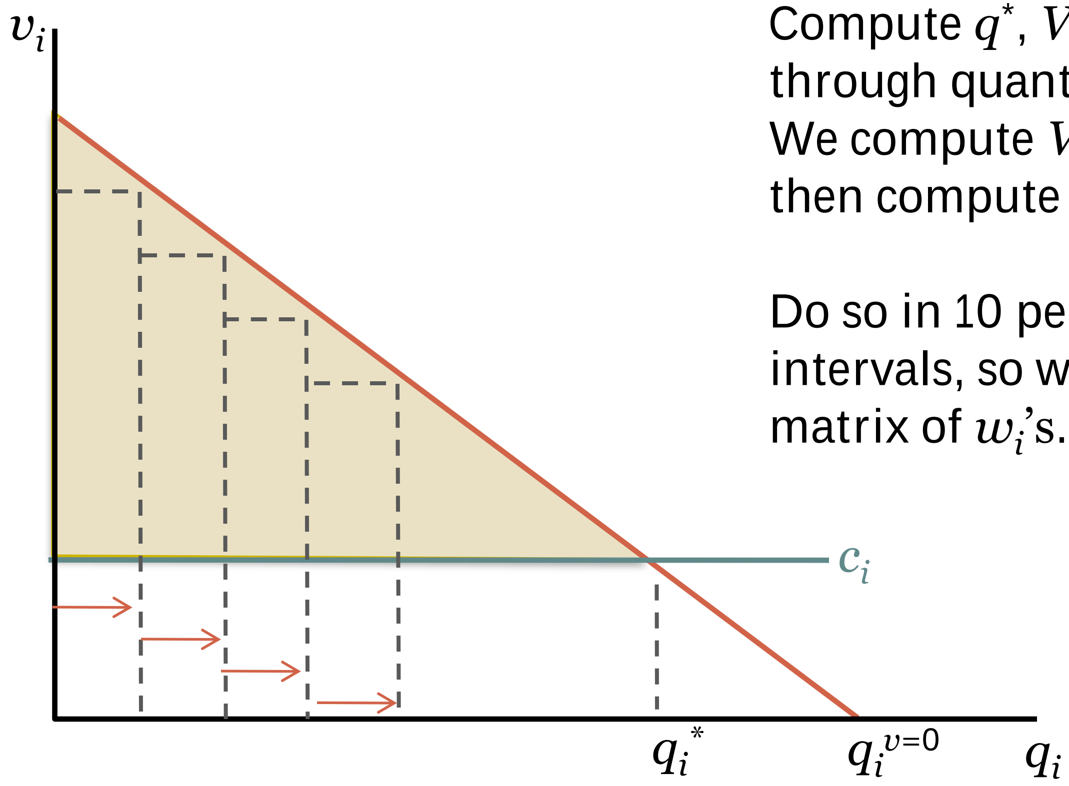
- Two Modalities, f and m
- f is shared
- m is personal
- c_f =40; c_m = 20
- Max value for m is 100
- Average share rate: $k = 2$
- Scale f demand to 200 (= 100·2)
- Personal Market = 2,000 persons
- Shared Market = 1,000 units (= 2,000/k)
- m is a mild net substitute for f

Willingness-to-Pay (Demand) System

$$p_m = 100 - \frac{100}{2000} q_m$$

$$p_f = (200 - 0.05 q_m) - \frac{200 - 0.05 q_m}{1000} q_f$$

Simulation Algorithm



Compute q^*, V^*, then scroll through quantities up to $q^{v=0}$. We compute V at each quantity then compute weights.

Do so in 10 percentage point intervals, so we have a 11x11 matrix of w_i's.

BAI Simulation: Two Modalities

$m\downarrow$ $f\rightarrow$	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	30.3	43	53.7	62.4	69.2	73.9	76.7	77.4	76.2	73.1
0.2	42.9	54.7	64.6	72.6	78.8	83.1	85.5	86	84.7	81.4
0.3	53.4	64.3	73.4	80.8	86.4	90.2	92.2	92.5	91	87.7
0.4	61.8	71.8	80.2	86.8	91.9	95.2	96.9	96.9	95.2	91.9
0.5	68.1	77.2	84.8	90.8	95.2	98.1	99.4	99.2	97.3	93.9
0.6	72.3	80.6	87.4	92.7	96.6	99	99.9	99.4	97.4	93.9
0.7	74.5	81.8	87.8	92.5	95.8	97.7	98.3	97.5	95.4	91.9
0.8	74.5	81	86.2	90.2	92.9	94.4	94.6	93.5	91.2	87.7
0.9	72.5	78.1	82.5	85.8	87.9	88.9	88.8	87.5	85	81.4
1.0	68.4	73.1	76.7	79.3	80.9	81.4	80.9	79.3	76.7	73.1

BAI Simulation: Two Modalities

(Zero costs; no substitution)

$m\downarrow$ $f\rightarrow$	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.1	19.0	27.5	35.0	41.5	47.0	51.5	55.0	57.5	59.0	59.5
0.2	27.5	36.0	43.5	50.0	55.5	60.0	63.5	66.0	67.5	68.0
0.3	35.0	43.5	51.0	57.5	63.0	67.5	71.0	73.5	75.0	75.5
0.4	41.5	50.0	57.5	64.0	69.5	74.0	77.5	80.0	81.5	82.0
0.5	47.0	55.5	63.0	69.5	75.0	79.5	83.0	85.5	87.0	87.5
0.6	51.5	60.0	67.5	74.0	79.5	84.0	87.5	90.0	91.5	92.0
0.7	55.0	63.5	71.0	77.5	83.0	87.5	91.0	93.5	95.0	95.5
0.8	57.5	66.0	73.5	80.0	85.5	90.0	93.5	96.0	97.5	98.0
0.9	59.0	67.5	75.0	81.5	87.0	91.5	95.0	97.5	99.0	99.5
1.0	59.5	68.0	75.5	82.0	87.5	92.0	95.5	98.0	99.5	100

BAI Simulation: Alternatives

Scenario 1	Cost of m (c_m):	20	25	30	35	40	45	50	55	60
	$q_m{}^*/q_m{}^{w=0}$	0.57	0.52	0.47	0.42	0.36	0.31	0.26	0.21	0.16
	$q_f^*/q_f^{w=0}$	0.72	0.73	0.74	0.75	0.76	0.76	0.77	0.78	0.78
Scenario 2	Cost of f (c_f):	40	45	50	55	60	65	70	75	80
	$q_m{}^*/q_m{}^{w=0}$	0.57	0.58	0.58	0.59	0.60	0.60	0.61	0.62	0.64
	$q_f^*/q_f^{w=0}$	0.72	0.68	0.65	0.61	0.57	0.54	0.50	0.46	0.41
Scenario 3	Max Value m	100	120	140	160	180	200	220	240	260
	$q_m{}^*/q_m{}^{w=0}$	0.57	0.64	0.70	0.73	0.76	0.79	0.81	0.82	0.84
	$q_f^*/q_f^{w=0}$	0.72	0.71	0.69	0.69	0.68	0.67	0.66	0.66	0.66

Can this be done?

Summary

- Performance is a value-based concept
- Any modality that generates value must be included in performance measures
  - Per- Capita Normalizations are misguided
  - Anyway, not clear how to do it with multiple modalities
- Combining heterogeneous modalities is tricky, but the problem is understood
- The underlying economics of deployment and adoption must be considered for good policy
  - Countries vary in their demand and cost profiles
  - Maximal deployment/adoption assumes external effects are enormous