Platform Competition and Broadband Uptake: Theory and Empirical Evidence from the European Union

Walter Distaso
University of Exeter
UK

Paolo Lupi
AGCOM
Italy

Fabio M. Manenti
Università di Padova
Italy

The Future of Broadband: Wired and Wireless?
Gainesville
February, 2005
eEurope 2005 action plan:

- recognizes the strategic importance of ICT for delivering large benefits to consumers in terms of new or improved products and services.
- main objective of the plan: to get a widespread availability of broadband access at competitive prices in Europe by 2005.

Policy debate

⇒ How to stimulate adoption of broadband technology.
⇒ General consensus: competition is the main driver of the adoption of broadband technologies.

Competition policies:

1. promote competition in the Digital Subscriber Line (DSL) segment of the market (intra-platform competition);
2. stimulate entry into the market for alternative platforms such as cable access or fiber optics (inter-platform competition).

Aim of the paper ⇒ to analyze the role of competition in promoting BB

DotEcon (2003) ⇒ broadband adoption can be stimulated more effectively promoting inter-platform competition, rather than focusing on DSL services (intra-platform competition).
Broadband technologies, a flexible definition:

- any access technology that guarantees connections to the net of greater quality (speed of data transfer) than traditional analogic - ISDN modems dial-up technologies.

**Digital Subscriber Line (DSL)**  it converts the standard telephone line into a high speed digital line. Connection speeds ranging from 256 Kbps to 52 Mbps.

**Cable modem**  A broadband technology that uses access lines for cable television (CATV). Connection speeds range from 1 to 10 Mbps.

**Fibre to the home (FTTH)**  A Fibre optic technology similar to standard cable that allows for transmission speeds of up to 10 Gbps.

**Satellite**  A broadband technology that uses satellite TV equipment to carry data. The downstream speed ranges between 300 Kbps and 2 Mbps.

**Fixed Wireless Access (FWA)**  A technology which uses radio links; it can reach speeds of over 2 Mbps.

**Power lines communications (PLC)**  It relies on the existing electricity distribution network to transmit data at speeds comparable to those offered by DSL.
PREVIOUS STUDIES


   the analysis is restricted to year 2001 and it does not capture the dynamic evolution of the BB market: price of BB, the price of dial-up services and a variable indicating the competitive conditions in the broadband market came out to be all statistically insignificant.


3. Garcia-Murillo & Gabel (2003) study the role of unbundling policies and other regulatory activities in local tlc on broadband adoption:

   ULL is not significant;
   privatization of the incumbent TLC carrier, and competition facilitate the deployment of broadband.
A SIMPLE MODEL OF PLATFORM COMPETITION

Assumptions:

1. Standard model of oligopoly competition between differentiated products.

2. Two BB access technologies, i.e. DSL and cable.

3. $n$ firms provide DSL access and $m$ firms provide cable access, with $n > m > 0$.

4. "Same technology" homogeneity and product differentiation across technologies.

5. Demand for DSL and cable technologies (Shy, 1995)

$$p_d = \alpha - \beta Q - \gamma Y,$$

$$p_c = \alpha - \gamma Q - \beta Y,$$

where $Q = \sum_{i}^{n} q_i$ is the total demand of DSL and $Y = \sum_{j}^{m} y_j$ is the total amount of cable access.

6. Imperfect "across technology" substitutability: $\beta > \gamma > 0$, i.e. the own price effect dominates.
On the cost side:

1. Each DSL firm pays the incumbent telecom firm for the unbundled local loop, \( c \) (marginal cost).

2. Cable firms do not need access to the local loop; they have to build their own infrastructure, i.e. a fixed cost of entry \( F \).

3. Individual DSL and Cable firms’ profits are

\[
\pi_d = (p_d - c)q_i, \quad \pi_c = p_c y_j - F,
\]

Solving the focs, the total amount of BB access, \( BB = Q + Y \) is

\[
BB(c, n, m) = \frac{n (\alpha \gamma m - \beta (\alpha - c) (1 + m))}{\gamma^2 mn - \beta^2 (1 + n) (1 + m)} + \frac{m (\gamma (\alpha - c) n - \alpha \beta (1 + n))}{\gamma^2 mn - \beta^2 (1 + n) (1 + m)}.
\]
INTRA-PLATFORM AND INTER-PLATFORM COMPETITION (HHI indexes)

- Degree of competition between DSL firms (intra-platform):

\[ HHI_{intra}(n, m) = \sum_{i=1}^{n} \frac{q_i^2}{Q^2}, \quad 0 < HHI_{intra} < 1 \]

- Degree of competition across platforms (inter-platform):

\[ HHI_{inter}(n, m) = \frac{Q^2}{BB^2} + \frac{Y^2}{BB^2} \quad 1/2 < HHI_{inter} < 1 \]

A look at the data:

<table>
<thead>
<tr>
<th></th>
<th>'01q2</th>
<th>'02q4</th>
<th>'04q1</th>
<th>'01q2</th>
<th>'02q4</th>
<th>'04q1</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT</td>
<td>0.88</td>
<td>0.68</td>
<td>0.60</td>
<td>0.54</td>
<td>0.52</td>
<td>0.50</td>
</tr>
<tr>
<td>BE</td>
<td>0.68</td>
<td>0.73</td>
<td>0.69</td>
<td>0.55</td>
<td>0.52</td>
<td>0.54</td>
</tr>
<tr>
<td>DE</td>
<td>1.00</td>
<td>0.89</td>
<td>0.82</td>
<td>0.97</td>
<td>0.97</td>
<td>0.96</td>
</tr>
<tr>
<td>DK</td>
<td>0.51</td>
<td>0.69</td>
<td>0.67</td>
<td>0.51</td>
<td>0.56</td>
<td>0.57</td>
</tr>
<tr>
<td>ES</td>
<td>0.78</td>
<td>0.64</td>
<td>0.67</td>
<td>0.62</td>
<td>0.61</td>
<td>0.63</td>
</tr>
<tr>
<td>FI</td>
<td>0.59</td>
<td>0.68</td>
<td>0.67</td>
<td>0.50</td>
<td>0.50</td>
<td>0.73</td>
</tr>
<tr>
<td>FR</td>
<td>0.82</td>
<td>0.59</td>
<td>0.51</td>
<td>0.50</td>
<td>0.72</td>
<td>0.81</td>
</tr>
<tr>
<td>IE</td>
<td>0.68</td>
<td>0.52</td>
<td>0.52</td>
<td>0.57</td>
<td>0.57</td>
<td>0.67</td>
</tr>
<tr>
<td>IT</td>
<td>0.51</td>
<td>0.57</td>
<td>0.55</td>
<td>0.89</td>
<td>0.84</td>
<td>0.89</td>
</tr>
<tr>
<td>LU</td>
<td>1.00</td>
<td>0.93</td>
<td>0.70</td>
<td>0.93</td>
<td>0.96</td>
<td>0.94</td>
</tr>
<tr>
<td>NL</td>
<td>0.94</td>
<td>0.58</td>
<td>0.52</td>
<td>0.72</td>
<td>0.58</td>
<td>0.50</td>
</tr>
<tr>
<td>PT</td>
<td>0.91</td>
<td>0.70</td>
<td>0.75</td>
<td>0.97</td>
<td>0.68</td>
<td>0.52</td>
</tr>
<tr>
<td>SE</td>
<td>0.96</td>
<td>0.63</td>
<td>0.61</td>
<td>0.54</td>
<td>0.52</td>
<td>0.51</td>
</tr>
<tr>
<td>UK</td>
<td>0.58</td>
<td>0.50</td>
<td>0.51</td>
<td>0.50</td>
<td>0.51</td>
<td>0.52</td>
</tr>
</tbody>
</table>

In most countries: \( dHHI_{intra} < 0 \); sign of \( dHHI_{inter} \) ambiguous
The relationship between \( HHI_{\text{inter}} \) and \( n, m \).

Markets are generally becoming more competitive:

\( \rightarrow \) we restrict the model to the case \( dn > 0 \) and \( dm > 0 \).

1. \( dHHI_{\text{inter}} < 0 \) if:
   
   a. DSL is the dominant technology (\( Q > Y \)) and \( dm > dn > 0 \): in this case both \( Q \) and \( Y \) may increase but cable market share increases relatively to DSL and inter-platform concentration decreases.
   
   b. \( Y > Q \) and \( dn > dm > 0 \).

2. \( dHHI_{\text{inter}} > 0 \) if:
   
   c. \( Q > Y \) and \( dn > dm > 0 \).

   d. \( Y > Q \) and \( dm > dn > 0 \).

Scenarios b. and d. are of little practical relevance.
SOME TESTABLE REMARKS

Remark 1. The lower the price for local loop unbundling (LLU), the higher the broadband adoption:

\[ \frac{dB}{dc} < 0. \]

Remark 2. A reduction in the price of LLU may be more effective in promoting broadband the lower inter-platform concentration; formally:

\[ \frac{d}{dHHI_{inter}} \left( \frac{dB}{dc} \right) > 0 \quad \text{for} \quad G < \frac{dn}{dm} < \overline{G}, \]

where

\[ \overline{G} = \frac{n(\alpha - c)[n\alpha(\beta - \gamma) + c\gamma n + \beta\alpha]}{m\alpha[(\alpha - c)\beta(m + 1) - \gamma\alpha m]} > G = \frac{n\gamma(\beta + n(\beta - \gamma))}{\beta(m + 1)(\beta + m(\beta - \gamma))} > 0 \]

Remark 1: a lower \( c \) enhances the competitive position of DSL firms and this translates into more BB access sold in the retail market.

Remark 2: the stimulating effect described in Remark 1 may be stronger the higher the degree of inter-platform competition.

Policy implication: a policy based on lowering \( c \) may be reinforced by pro-competitive measures aimed at stimulating competition between different platforms.
Remark 3. The lower the Herfindhal indexes, relative to both inter and intra-platform concentration, the larger total broadband access. Formally:

\[
\frac{dBB}{dHHI_{intra}} < 0 \quad \text{and} \quad \frac{dBB}{dHHI_{inter}} < 0.
\]

Corollary 1. Inter-platform competition may be more effective than intra-platform in stimulating broadband uptake. Formally:

\[
\frac{dBB}{dHHI_{inter}} < \frac{dBB}{dHHI_{intra}} \quad \text{for} \quad \frac{dn}{dm} > \tilde{G} \left( -\frac{\delta HHI_{inter}}{\delta m} \left( \frac{\delta HHI_{inter}}{\delta n} + \frac{1}{n^2} \right) \right)
\]

Remark 3: Both intra and inter-platform competition stimulate adoption through low prices.

\[\leftarrow\quad \text{nevertheless, when not accompanied by a similar pro-competitive policy in the cable segment of the market (formally, when } \frac{dn}{dm} \text{ is large enough), the impact of intraDSL competition may be smoothed by the negative impact induced by a larger inter-platform concentration.}\]

\[\leftarrow\quad \text{a policy should therefore be aimed at balancing entry in the DSL and in the cable segments of the market.}\]
**THE DATA**: the Dataset has been built by joining different sources:

1. Data related to the number of analogic and ISDN digital lines (as well as the number of DSL, CATV, broadband upgraded CATV, fiber optic and satellite lines) were taken from *Telecom Markets*.

2. Data on
   - input prices such as unbundling of the local loop, shared access, leased lines one-off and recurring fees;
   - the regulation of the rights of way,

were taken from the annual reports of the *European Commission*.

3. Data from reports of the European Commission were complemented with data taken from *The Cross Country Analysis*.

All EU-15 countries except Greece: ⇒ Austria, Belgium, Denmark, France, Finland, Germany, Luxembourg, Ireland, Italy, Netherlands, Portugal, Spain, Sweden and UK.

Quarterly time intervals; from the 4th quarter 2000 until 2nd quarter 2004:
⇒ 15 time periods and 14 countries.
THE LIST OF VARIABLES

**PENBB** A measure of BB penetration which weights the number of BB lines by the total number of access lines
\[ \rightarrow \text{a measure of the number of all possible access lines that have been upgraded to transmit high-speed data.} \]

**INTRA** An HHI index measuring the level of market concentration/competition within the DSL technological platform.

**INTER** An HHI index measuring the level of market competition/concentration across different technological platforms.

**ROW1** A dichotomous variable taking the value of 1 when rights of way and digging permits over public land are granted by a single central authority and 0 when rights of way are granted by local authorities.

**ROW2** A dichotomous variable taking the value of 1 when operators experience delays in getting rights of way or digging permits and 0 when no delays are reported.

**LL12** Price of LLU: one third of the one-off charge to the yearly fee.

**LLP** Price of a leased line: one-off fee + the annual charge of 2 km 2Mbps leased line.

**LCC** Price of a ten minutes local call on the incumbent’s fixed network.
ECONOMETRIC SPECIFICATION AND ESTIMATION RESULTS

Three models have been estimated

\[
PENBB_{i,t} = \text{const + time effects} + \beta_1 LL{P}_{i,t} + \beta_2 LL{12}_{i,t} + \beta_3 LL{C}_{i,t} + \beta_4 \text{ROW1}_{i,t} + \beta_5 \text{ROW2}_{i,t} + \beta_6 \text{INTRA}_{i,t} + \beta_7 \text{INTER}_{i,t} + \beta_8 \text{INTER}_{i,t} \times LL{P}_{i,t} + \beta_9 \text{INTER}_{i,t} \times LL{12}_{i,t} + \varepsilon_{i,t}, \quad (1)
\]

\[
PENBB_{i,t} = \text{const + time effects} + \beta_1 LL{P}_{i,t} + \beta_2 LL{12}_{i,t} + \beta_3 LL{C}_{i,t} + \beta_4 \text{INTRA}_{i,t} + \beta_5 \text{INTER}_{i,t} + \beta_6 \text{INTER}_{i,t} \times LL{P}_{i,t} + \beta_7 \text{INTER}_{i,t} \times LL{12}_{i,t} + \varepsilon_{i,t} \quad (2)
\]

and

\[
PENBB_{i,t} = \text{const + time effects} + \beta_1 LL{P}_{i,t} + \beta_2 LL{12}_{i,t} + \beta_3 LL{C}_{i,t} + \beta_4 \text{INTRA}_{i,t} + \beta_5 \text{INTER}_{i,t} + \beta_6 \text{INTER}_{i,t} \times LL{P}_{i,t} + \beta_7 \text{INTER}_{i,t} \times LL{12}_{i,t} + \beta_8 \text{GDPPC}_{i,t} + \varepsilon_{i,t}, \quad (3)
\]

where \( \varepsilon_{i,t} \) is an error term and model (3) controls for GDP per capita (in real terms).
NOTE:

→ Time trend components have been accounted for including time effects in the estimated equations.

→ As for the constant term, both the Fixed Effects (FE) and Random Effects (RE) specifications have been estimated and tested.

→ Given the way the measures of inter and intra platform competition have been constructed, there may be some concerns as to what extent they can be treated as exogenous variables:
  
  ⇒ Therefore also an Instrumental Variable (IV) regression has been performed, instrumenting the competition measures with their lagged values.

→ We treat the price of unbundling the local loop and leased lines as exogenous, since these variables are typically regulated and therefore not endogenously determined.
Table 2: Panel regression results (figures in parentheses refer to $t$ statistics for coefficients and to $p$ values for tests)

<table>
<thead>
<tr>
<th>Specification</th>
<th>Model (3)</th>
<th>Model (4)</th>
<th>Model (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FE</td>
<td>RE</td>
<td>IV</td>
</tr>
<tr>
<td>LLP</td>
<td>-.00013</td>
<td>-.00015</td>
<td>-.00034</td>
</tr>
<tr>
<td></td>
<td>(-1.74)</td>
<td>(-1.85)</td>
<td>(-3.21)</td>
</tr>
<tr>
<td>LLU12</td>
<td>-.00132</td>
<td>-.001074</td>
<td>-.002866</td>
</tr>
<tr>
<td></td>
<td>(-2.47)</td>
<td>(-3.50)</td>
<td>(-6.91)</td>
</tr>
<tr>
<td>LCC</td>
<td>.002255</td>
<td>.000377</td>
<td>-.000438</td>
</tr>
<tr>
<td></td>
<td>(1.89)</td>
<td>(0.77)</td>
<td>(-1.25)</td>
</tr>
<tr>
<td>ROW1</td>
<td>.028359</td>
<td>.024886</td>
<td>.037957</td>
</tr>
<tr>
<td></td>
<td>(1.75)</td>
<td>(1.15)</td>
<td>(1.22)</td>
</tr>
<tr>
<td>ROW2</td>
<td>.042631</td>
<td>-.018344</td>
<td>-.012642</td>
</tr>
<tr>
<td></td>
<td>(1.56)</td>
<td>(-0.90)</td>
<td>(-0.85)</td>
</tr>
<tr>
<td>INTRA</td>
<td>.036425</td>
<td>.029877</td>
<td>.019254</td>
</tr>
<tr>
<td></td>
<td>(1.21)</td>
<td>(1.12)</td>
<td>(0.48)</td>
</tr>
<tr>
<td>INTER</td>
<td>-.436742</td>
<td>-.480193</td>
<td>-1.385403</td>
</tr>
<tr>
<td></td>
<td>(-2.98)</td>
<td>(-4.14)</td>
<td>(-6.80)</td>
</tr>
<tr>
<td>INTER * LLP</td>
<td>.000011</td>
<td>.000018</td>
<td>.000052</td>
</tr>
<tr>
<td></td>
<td>(1.84)</td>
<td>(1.89)</td>
<td>(3.28)</td>
</tr>
<tr>
<td>INTER * LLU12</td>
<td>.001369</td>
<td>.001295</td>
<td>.004093</td>
</tr>
<tr>
<td></td>
<td>(2.42)</td>
<td>(2.93)</td>
<td>(5.37)</td>
</tr>
<tr>
<td>GDPPC</td>
<td>.245760</td>
<td>.361966</td>
<td>.979764</td>
</tr>
<tr>
<td></td>
<td>(1.95)</td>
<td>(4.00)</td>
<td>(6.78)</td>
</tr>
<tr>
<td>CONST</td>
<td>.245760</td>
<td>.361966</td>
<td>.979764</td>
</tr>
<tr>
<td></td>
<td>(1.95)</td>
<td>(4.00)</td>
<td>(6.78)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.53</td>
<td>0.64</td>
<td>0.59</td>
</tr>
<tr>
<td>LM test</td>
<td>126.95</td>
<td>0.59</td>
<td>127.55</td>
</tr>
<tr>
<td>Hausman (RE vs. FE)</td>
<td>15.56</td>
<td>29.07</td>
<td>6.96</td>
</tr>
<tr>
<td></td>
<td>(1.11)</td>
<td>(0.00)</td>
<td>(0.64)</td>
</tr>
<tr>
<td>Hausman (RE vs. IV)</td>
<td>29.42</td>
<td>17.89</td>
<td>36.58</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.02)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Wald (joint)</td>
<td>34.71</td>
<td>506.40</td>
<td>273.42</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
</tbody>
</table>
RESULTS

1. As predicted by Remark 1:
   ← the LLU price has a negative effect on BB diffusion.
   ← the price of leased lines is negative and significant.
   These are important inputs for the provision of DSL/BB services.

2. The price of local calls is positively related with the diffusion of broadband (except for model (1) estimated with IV) but insignificant.
   ← being the primary vehicle through which narrow band Internet access is provided, an increase in the price of local calls should push customers towards the adoption of broadband access to the internet.
   ← the fact that the coefficient is not statistically significant confirms some previous findings in related literature that place NB and BB in separate markets (Hausmann et al., 2001).
4 ROW1 has the expected sign (less delay under centralised authority granting ROW to broadband access providers), but is not statistically significant (except in the FE regression).

5 The same for ROW2: expected negative sign (apart from FE regression) but not statistically significant; the variables ROW1/2 are dropped in the alternative specifications of models (2) and (3).

6 HHI for inter-platform competition has negative and statistically significant coefficient:

\[ \leftrightarrow \text{Remark 3 is confirmed.} \]

\[ \leftrightarrow \text{Competition between different platforms seems to be one of the main drivers of broadband uptake.} \]
7 HHI for intra-platform (intraDSL) has the wrong sign but it is always insignificant and numerically close to zero:

\[\leftarrow \text{The data support Corollary 1} \Rightarrow \text{the stimulating role of intraDSL competition seems to be overwhelmed by the negative "indirect" effect of increased inter-platform competition induced by promoting entry into the DSL segment of the market.}\]

9 Cross products between the LLP, LL12 and the inter-platform measure of competition have both positive and significant coefficients:

\[\leftarrow \text{Remark 2 is confirmed} \Rightarrow \text{the stimulating effect of a reduction in the price of LLU will be reinforced by a high level of competition between technological platforms.}\]

10 The sign and significance of the estimated parameters remain fairly constant across the different specifications estimated.