Modelling Dynamic ICT Services Markets

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Motivation and contribution

• ICT products have some unique properties influencing market adoption
  – Network effects
• These properties are crucial to understand in order to increase revenue for companies when offering ICT services
• We provide a theoretical framework and a first step to quantitatively model ICT services markets
Outline

• ICT services markets
  – Network effects
  – Positive feedback
  – Churning
• Quantifying market parameters
• Discrete event simulation model
• Market evolution
ICT service markets
Assumptions

• Homogenous service
  – All implementations of the considered service implement the service in the same way

• Exclusive market
  – User can subscribe to maximum one service

• Equal value
  – User put the same value on each product, i.e. we assume equal price and popularity among products
Product diffusion – S curve

\[ R_t = \left(1 + e^{\ln(R_0^{-1} - 1) - \left(\frac{2\ln(9)}{\Delta T}\right)_t}\right)^{-1} \]
Suitable services

• Instant Messaging services
  – Video, text, voice conversation
• Mobile telephony
  – Voice service
• Mobile Operating Systems
  – iOS, Android, Windows Phone
• Web browsers
  – IE vs Netscape vs Firefox
Positive feedback

- Positive feedback rises due to
  - Positive network effects
  - Demand and supply side
  - Direct and indirect effects

- Model positive feedback using Polya’s urn problem

- Scale parameter $\gamma$
  - Express network externalities

$$p_{i,t} = \frac{s_{i,t}^\gamma}{k \sum_{j=1}^{k} s_{j,t}^\gamma}.$$
Polya’s urn problem
Churning

- Loss/gain of users to other service providers in the market
- Influenced by switching costs
- Assume a certain number of users churn each time period
Mathematical model

- Market with positive feedback, churning and two service providers
- Described by differential equations
- Cannot be solved analytically

\[
\frac{ds_{i,t}}{dt} = \beta \frac{s_{i,t}}{N} \left(1 - \frac{s_{1,t}}{N} - \frac{s_{2,t}}{N}\right) + f(t, t + \Delta)p_{i,t}
\]
Mathematical model – plane portrait
Simulations

• Mathematical model has no closed form solutions
• Results obtained through simulations
• SIMULA/DEMOS
  – Monte carlo type of simulations
  – New customers are discrete events
  – Churning customers are discrete events
Numerical evaluation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
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<tbody>
<tr>
<td>N</td>
<td>Total number of users in the market</td>
<td>100,000,000</td>
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<tr>
<td>k</td>
<td>The number of service providers</td>
<td>2 or 4</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>Scale parameter</td>
<td>1.4-2.0</td>
</tr>
<tr>
<td>$\theta$</td>
<td>Churn parameter (yearly churning)</td>
<td>30%</td>
</tr>
<tr>
<td>$R_0$</td>
<td>Relative share of users already using the considered service at time $t=0$</td>
<td>0.001</td>
</tr>
<tr>
<td>$\Delta T$</td>
<td>Number of years for the service to reach 90% user penetration from 10% penetration</td>
<td>5</td>
</tr>
<tr>
<td>$Q_0$</td>
<td>Start conditions for time $t=0$</td>
<td>${2500,2500$, $2500,2500},$ ${5000,5000}$</td>
</tr>
</tbody>
</table>
Market without churning
Market with churning
High positive feedback
Low positive feedback
Web browser market (real data)
Conclusions

• Developed a market simulator for dynamic ICT services markets
• Quantify parameters influencing the outcome of competition in ICT services markets
• Future work will extend the model
  – Pricing
  – Loyalty
  – Popularity