The boundaries of ICT forecasting

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The Second Workshop on ICT and Innovation Forecasting
From Theory to Practice & Applications
Recap on last years’ workshop – partial list

- Forecasting Smartphone Features (Heikki Hämmäinen)
- Value of Social Media as a source for forecasts (Paul Rappaport)
- Reorganisation of forecasting department (Andrew Beurschgens)
- Combination of time-series and diffusion modelling in ICT (Dimitris Varoutas)

Recent literature

+ Meade & Islam (IJF, 2015) on existing literature

More recent, 2014 on: limited to aggregate studies including environmental impact
Objectives & Agenda

To examine ICT demand in the context of changing devices, media and usage

• Identify forecasting challenges
• Examples
  – YouTube
  – Voice vs data & Media choice
  – Apps
  – Engineers
• Evaluate current methods
• Tentatively suggest routes towards ‘best practice’
End Uses
- Entertainment (video, TV)
- games
- medical
- home shopping
- social network via
- internet
- call centres
- smartphone/tablet

End Uses
- data transfer
- video
- group work/play
- CAD/CAM

Forecasts of equipment, access and usage need to be compatible
- but forecasts can be based on only one part of the system

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Different devices & technologies competing

Application Scenario + Choice of Media & App (Established or New)

Entrants

Switchers

Devices & Technology A
- Attributes A

Switchers

To Firm A

Leavers

Devices & Technology B
Attributes B

To Firm B

Entrants

Enter

Exit
A Hierarchy of Forecasts

- Overall B&C demand for an application
e.g. video downloads, medical diagnosis

- Competition within ‘technologies’
to service application
  - e.g. mobile vs tablet

- Competition between suppliers: revenue and operational implications

Forecasting Implications

⇒ e.g. for entrants, business model (price leadership), contract
Why is ICT forecasting interesting?

• It’s our job and our industry!

• New methods?
  – No, not really!
  – Established methods:
    • Judgment: individual and survey, time series, causal (indicator)

• But new problem structures
  – Competition between technologies/services (established vs new)
  – Limited data

• Rapid changes in consumer behaviour
Change in Usage Behaviour matters for ICT

Autoplay for videos first launched by Facebook
- Inflates numbers of views
- Increased data volume
- Impact on network infrastructure?

VoiceCall now enabled for all Whatsapp users
- Increased data volume
- Impact on providers?
Requirements of a strategic ICT forecast

- Long (5 to 10 year) forecast of market penetration
  - Forecasts needed for investment decisions
  - For novel use
  - For new technology or service

- Forecasts by period

- Share forecasts
  - Vs. competing technologies or services

- Implications for equipment

- Uncertainty estimates by period and cumulatively
The standard methods
(Goodwin et al., The challenge of pre-launch forecasting for new durable products, IJF, 2014)

• Management judgment (by individuals or groups)
  – Directly of adoption/use by experts, Delphi
  – Indirectly through analogies with earlier similar situations

• Judgments by potential customers
  – Intentions surveys (what is the probability you will use this service next year, 2 years, 5 years)
  – Choice models (which of the following options would you choose)
    • These econometric models are based on judgmental choice data

• Formal quantitative models
  – Growth S-shaped curves; econometric models
Developing Adoption and Usage Scenarios

Core Assumption:

A product (or service) is composed of a set of attributes

These attributes are valued by a consumer to give an overall value to the product

• Where usage is established
  – Usage forecast by statistical methods
    • In the short term extrapolative methods (e.g. growth curves)
    • In long term, market penetration levels (Analogy?)
  – Implications for choice of (new) device or technology to deliver?

• New (enhanced) feature choice: product/service improvement
  – Value vs price in competition
    • E.g. camera on mobile
  – Methods: choice models to value features

• Really new (to the world) usage
  – A ‘really’ new product is one with a key new attribute that earlier products had not included
    • No clearly analogous experience (e.g. MMORPG, Touchscreen, Facebook, Google glasses, Uber?)
Choosing between alternative products or services

- Consider the choice you make when deciding how to communicate with someone at a distance (e.g., mobile, fixed line, IMS, VOIP).

- What are the key attributes that affect your choice, and what circumstances affect their relative value to you?

- In using/adopting a particular product, a consumer maximizes her utility compared to alternatives (such as not using it)

The Attributes of a product/service characterize the key features that may distinguish it from its competitors.

Core assumption: People value a product by valuing its individual attributes. May not be additive.
Drivers of consumer/ business choice

• New applications
  – E.g contactless payment systems, fitness apps,
• New features
  – E.g. camera, GPS, NFC (near field communication)
• New media
  – E.g. Smartphone, tablet
• New devices
  – e.g. iWatch
• Better performance
  – 4G
• Lower price
• Bundling effects (e.g. Kindle appl with Kindle Fire)
• Network effects
  – Segmented adoption paths

But we don’t have much choice of methods!
Estimating Market Potential: survey the potential customers to estimate market potential
(Goodwin et al., Int, J. Forecasting, 2014)

• Using intentions or choice studies
  o Identify an appropriate sample of respondents
    ✓ Aim for probabilistic estimates of purchase for various market segments
    ✓ Weight the results to produce the final forecast
  o For choice models, identify the product attributes for the product and its competition
    ✓ The consumer identifies the important attributes in making the choice
    ✓ Chooses from a realistic number of alternatives (choice experiments)
  o Question respondents in a realistic context
    ✓ Simulated buying and product environment

• Issues
  o Ensuring the choice set is realistic
  o Heterogeneity of potential users
  o Changing consumer tastes: bias in responses – and how to moderate it?
Improving on measuring intentions

<table>
<thead>
<tr>
<th></th>
<th>I will not have bought one – a GPS app</th>
<th></th>
<th>I will have bought one – a GPS app</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 months from now</td>
<td>0%</td>
<td>10%</td>
<td>..........</td>
</tr>
<tr>
<td>12 months</td>
<td>0%</td>
<td>10%</td>
<td>..........</td>
</tr>
<tr>
<td>2 years</td>
<td>0%</td>
<td>10%</td>
<td>..........</td>
</tr>
<tr>
<td>3 years</td>
<td>0%</td>
<td>10%</td>
<td>..........</td>
</tr>
<tr>
<td>5 years</td>
<td>0%</td>
<td>10%</td>
<td>..........</td>
</tr>
</tbody>
</table>

Estimates are of cumulative adoption rate
- Applied to the adoption of GPS in mobile
- Proved more accurate

*But limited comparison of one product and few out-of-sample data points*

Also, Realism in the choice environment
Examples: at the boundaries of ICT research

- Youtube
- Voice vs data
- Mobile phone apps
- Engineers

*But not the boundaries of practice!*
Forecasting for YouTube

- Unique users
- Unique views
- Attributes
  - Content
  - Easy of access + indexing
  - Ease/ speed of uploading
  - Advertising content
  - Price (for viewer and uploader)
  - Capacity
  - Network effects (geography)
  - Copyright
- Competitors
Competition drives the strategic direction at YouTube

At its launch
• Choice of the Business model (e.g. free vs. paid account)
• Content strategy (e.g. Investing in own contributors)
• Choice of the market penetration strategy (e.g. globally vs. locally)
• Technological advantage

By today
• Retain advertising revenue (e.g. more tailored to the content)
• Trend for paid and licensed content (e.g. Introduction of paid music channel)

Competitive position
• Fully integrated into Google search engine
• Free for uploading content, few restrictions
• No user account needed
• Revenue participation for its contributors
Forecasting for YouTube

- Developing Consumer preferences (e.g. pay for premium content):
  - choice models

- Competition (new competitors)

- Forecasts for unique views (market potential)
  - Revenue per view

Example 1: YouTube

Air France – France is in the air: 49 M views
Market potential – an example
Estimating consumer demand for voice vs text

• Application – the scenario of conversation type
• Importance
  – Business model, revenue projection, equipment requirements

• Usage of alternative media
  – Depends on changing pattern of communications
    The application scenarios,
    • e.g. long personal conversation
    • Short formal to confirm critical information
    • Transaction

• Competing Media for delivering the application
  – Mobile, fixed line, email, SMS, IMS, Internet telephony, social network

N.B. devices now deliver most media
The level of attribute for each medium

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Synchronicity</th>
<th>Multitasking</th>
<th>Quality</th>
<th>Price</th>
<th>Easy to use</th>
<th>Mobility</th>
<th>Privacy</th>
<th>Video</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMS</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
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<tr>
<td>Land_line voice</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
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<td>Email</td>
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<td>0</td>
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<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Mobile voice</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Internet telephony</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Instant message</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Social network</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Note the convergence since the research was carried out

Example 2: Voice vs data

Identified through focus group
### A summary of the choice analysis result_importance of attributes

#### Rating of Importance of attribute

<table>
<thead>
<tr>
<th>Group</th>
<th>Attribute 1</th>
<th>Attribute 2</th>
<th>Attribute 3</th>
<th>Attribute 4</th>
<th>Attribute 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1G1</td>
<td>quality(41%)</td>
<td>price(37%)</td>
<td>mobility(11%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1G2</td>
<td>price</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1G3</td>
<td>quality(37%)</td>
<td></td>
<td></td>
<td></td>
<td>multi_tasking(13%)</td>
</tr>
<tr>
<td>C2G1</td>
<td>quality(38%)</td>
<td>privacy(21%)</td>
<td>synchronicity(14%)</td>
<td>mobility(11%)</td>
<td></td>
</tr>
<tr>
<td>C2G2</td>
<td>quality(34%)</td>
<td>privacy(20%)</td>
<td>mobility(16%)</td>
<td>multi_tasking(16%)</td>
<td></td>
</tr>
<tr>
<td>C2G3</td>
<td>multi_tasking(39%)</td>
<td>mobility(30%)</td>
<td>quality(22%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3G1</td>
<td>synchronicity(35%)</td>
<td>price(27%)</td>
<td>privacy(20%)</td>
<td>quality(14%)</td>
<td></td>
</tr>
<tr>
<td>C3G2</td>
<td>synchronicity(32%)</td>
<td>quality(32%)</td>
<td>price(25%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3G3</td>
<td>synchronicity(36%)</td>
<td>price(27%)</td>
<td>privacy(20%)</td>
<td>quality(11%)</td>
<td></td>
</tr>
<tr>
<td>C4G1</td>
<td>privacy(45%)</td>
<td>quality(26%) (-)</td>
<td>mobility(14%)</td>
<td>multi_tasking(12%)</td>
<td></td>
</tr>
<tr>
<td>C4G2</td>
<td>multi_tasking(33%)</td>
<td>mobility(32%)</td>
<td>privacy(27%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C4G3</td>
<td>privacy(60%)</td>
<td>mobility(28%)</td>
<td>quality(25%) (-)</td>
<td>multi_tasking(14%)</td>
<td></td>
</tr>
<tr>
<td>C5</td>
<td>synchronicity(37%)</td>
<td>price(28%)</td>
<td>quality(22%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C6</td>
<td>multi_tasking(37%) (-)</td>
<td>synchronicity(33%)</td>
<td>price(14%)</td>
<td>quality(12%)</td>
<td></td>
</tr>
</tbody>
</table>

#### Scenario two

(Spend a long time chatting with your parents or friends)

**C2G1:** responses of homogeneous group one in scenario two

*Example 2: Voice vs data*
Voice vs Data: Case study issues

• Structure of the problem
  – Media type + attributes
  – Conversation type

• Method
  – Segmented survey and choice

• To produce a forecast
  – Forecasts adoption and use of data vs voice: a strategic aim in defining viable business models
  – Application Scenarios/ forecasts needed for conversation type
  – Assumes media preferences are unchanging
    • But are they?

• So does this complex structure help?
  – In understanding
  – Basis of a purely judgmental forecast?
• Aiming at the following logical structure
  - Forecast mobile network requirements based on service usage
  - Forecast service usage based on ownership (device, apps)
  - Exploit ”device feature” as a binding between service, device and app

• Main focus on device feature diffusion

• Beneficiaries of device feature diffusion forecasts
  - App developers who anticipate the feature base
  - Device manufacturers who prioritize features
  - Operators who develop and improve services
  - Network equipment and device component providers to prioritize R&D
Example 3: Mobile device features

Operating systems

Shares of mobile handset operating systems

Shares of smartphone operating systems

- Nokia Series 40
  - 5. ed. (13%)
  - 1.3. ed. (7%)
  - Nokia OS (7%)
- Others (10%)
- Smartphones (45%)

- iOS (6%)
- Android (11%)
- Windows Phone (4%)
- Symbian^3/
  - Anna/Belle (7%)
- Symbian
  - 1.5. ed. (15%)
- Others (1%)
Three models fitted:

1) Bass (F)
2) Simple Logistic (S)
3) Gompertz (NS)

Gompertz chosen for further analysis:

1) Three-parameter estimates for 10 features
2) Two-parameter fits for rest, saturation level from (1): 90%

Device population evolution model
Combination of three sub-models

(1) Product category diffusion model
- Number of first and additional unit purchases during t
- Number of units sold during t

(2) Product unit replacement model
- Numbers of units discarded during t
- Numbers of units sold during 0 … t-1 in population

(3) Product feature dissemination model
- Numbers of units sold during 0 … t in population
- Feature market shares in 0 … t
- Feature penetrations in 0 … t
Mobile handset model life cycle

- Model intro-to-market delay:
  - 4.2 months on average
  - 90% of models in less than 8 months

- Model time to peak sales:
  - 6 months from start of sales

- Model sales period:
  - Typically 1-2 years
  - ~50% during first 8-10 months

- Unit mean lifetime: 2.6 years
  - "Long tail": after 5 years, still 20% of handsets in use


Note: Intro-to-market delay not shown in the figure
Forecasts for diffusion of selected features

Steady growth in feature diffusion
• WCDMA (3G) predicted to reach 80% penetration in two years, WLAN (3G+) in three years

Features diffuse in bundles
• Smooth cumulative pattern
Conclusions on Feature Model

• Strictly quantitative driven by past data
  – Good data base
  – Gompertz diffusion curves

• Problem well-structured but sequential
  – Ownership drives usage
  – Builds on the interactions between device, feature and OS
  – Innovation driven by suppliers
  – Features growth independent (though depends on installed base)

• More ‘consumer behaviour’ needed as input
  – Feature model does not interact with usage
  – New features placing demand on equipment?
  – Excludes changes in consumer preference
  – No validation
Forecasting the No. of Engineers (BSkyB): an operational forecast

Structure:
- Demand for ‘boxes’, upgrades drives Total work
- Disaggregated by region
- Forecasts needed of completion rates
- Travel times

Delivering regional engineer hours forecast

Conclusions
- Geographical hierarchy useful in improving accuracy
- Key issue is the accuracy of new work forecasts
- Depends again on changes in consumer choice
- Short-term unproblematic but...
Conclusions on choice models and intentions

- Multi-attribute choice model delivers:
  - Current value of each attribute
  - Value of each medium (depending on application scenario)
  - Probabilistic forecasts weighted by segment and scenario deliver forecasts of the probability of e.g. choosing text vs voice, device

But

- Valuations of attributes and therefore mediums change over time, e.g. selfies, security of transmission
- Communication preferences (Application scenarios) change, e.g. growth of interactive short conversations, communication with ‘Friends and ‘followers, e.g. growth of Twitter
- In medium term penetration forecasts, the choice set is not known
  - e.g. in 2000, the choice set for services to deliver video did not include IMS.
  - Rise of WhatsApp reported cost mobile providers $32.5B in 2013!

Uncertainty in the medium/long term very high
A novel perspective on modelling ICT

Basic consumer need, e.g. communicate C2C

Alternative applications scenarios, e.g. video message vs conversation

Changing preferences

Changing preferences

Alternative features, e.g. mobility, video

Competing media, e.g. Mobile vs Tablet vs Desktop

Alternative apps, e.g. VOIP vs twitter

Alternative OS

Alternative equipment demands

Technology exposure changes consumer choices (and weightings of features)
Identifying Uncertainties in New Product Forecasting

New product forecasting requires multiple diverse methods

(Goodwin et al., IJF)
Conclusions & Recommendation: What are the choices for new applications?

For the practitioner

• Where there is data, conventional methods work
  – Decompose the problem
  – Apply statistical methods
  – Modify parameters by group analogies + judgment

• In novel adoption and usage (tentatively)
  – Decompose again
  – Identify through choice experiments current attribute weightings
  – Consider modifying those weightings
  – Probabilities of segmented populations choosing use
  – Use diverse approaches to understand/ highlight uncertainties
Conclusions II

Practical Recommendations very tentative
(Research is extremely limited)

But what alternatives are there:
• Unstructured judgment?
• Delphi?

For the Researcher:
• Gains to be made in consumer based choice studies
• Develop a long horizon research agenda
  ✓ Intentions, choice and diffusion
  ✓ Can new data sources (YouTube, Twitter, Google trends) be useful?
    In the short term?
    For longer term market forecasting?
Questions, solutions and comments?