Valuation of Innovation and Intellectual Property: The Case of iPhone

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“Today Apple is reinventing the phone...and boy, we have patented it.”

- Steve Jobs Jan. 9, 2007 -
What do we do?

• We present a “new” innovation and IP valuation method

1. We adopt an old method of valuation to
   • new purposes
   • old-but-forgotten purposes
   • usual purposes

2. We do this in an advanced way

• We use this method to value Apple’s iPhone
What do we do?

1) We use event study method to value a number of innovation and IP related events
   - Patent applications and grants
   - Trademark registrations
   - Rumors and news

2) We distinguish “important” events from “noise” events by using stock market and internet activity data
What do we do?

- We consider the marginal impact of each event on the market value of
  1. Apple
     - private value
  2. Its major competitors
     - spillovers & business stealing effects
  3. Its major suppliers
     - value effects within the supply chain
Why Apple?

• Event study uses daily stock market data and works the better the more efficient the market is
  
  – Apple’s stock is liquid, price discovery should be excellent
  
  – Apple is visible:
    • Keen analyst and investor following
    • Its innovation and IP management process is actively monitored by media and internet community
Why iPhone?

- A major case of cumulative innovation
  
  – Dramatic consequences to Apple, the mobile phone industry, the stock market, and even to the (Finnish) economy
  
  - shares of industry-profits, Nokia v. Apple
    – Summer 2007: 60% v. 1%,
    – Summer of 2011: 2% v. 56%

- A key factor making Apple the most valuable firm in the history
Figure 5: Apple Inc. Market Capitalization (in Billions)
Why iPhone?

• Mobile phones is an industry where it is difficult to enter
  – Network externalities
  – Standardization
  – Patent thickets

-> extensive litigation and trading of intellectual property
  – What is the size of the cake in this trading and litigation?
Literature

• Valuation of innovation using stock market reactions to news announcements
  – Chaney et al., J.Business-91 etc.

• IP valuation using daily stock market reactions
  – Patent litigation: Curtler & Summers, RAND-88 etc
  – Patent grants: Austin, AER-93, Patent and Ward RP-11 +some other

• Using patents & news to identify innovation:
  – Lerner, JFE-06
The rest of the talk

• Identification of relevant events
• Estimation methods
• Results
• Conclusion
Identification of our events

• Identification of news & rumors
  – Lexis-Nexis, Bloomberg, Google
    • Identification easy
      – 1st: Dec 15, 1999

• Identification of patents & trademarks
  – USPTO+others
    • Identification patents difficult
    • Trademarks easy
      – 1st: Singapore, Oct 2002

• Elimination of contaminated events
Identification of iPhone related patents

• How to distinguish iPhone related patents from other patents of Apple?

1. We read a few iPhone related patents
2. Used those as a base for a keyword search algorithm
3. Read all patent documents that the algorithm produced

-> yields 213 iPhone related patents
   (Feb 7, 2002->Dec 31, 2009)
Identification of important events

- Use abnormal *trading volume* as an indicator of information relevance (Tkac-JFQA99)

\[ V_{i,t} = \gamma_i + \delta_i V_{m,t} + \lambda_i D_t + \varepsilon_{i,t} \]

\[ V = \log(Vol / Mcap) \]

- In an analogous way we use an abnormal *Google search volume* as an indicator of information relevance
Figure 2: Apple, Inc. abnormal daily trading volume
Summary of events by the end of 2009

<table>
<thead>
<tr>
<th>Event</th>
<th>Total</th>
<th>Abn</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>News</td>
<td>74</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Pat app</td>
<td>97</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Pat grants</td>
<td>72</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Trademarks</td>
<td>6</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>249</td>
<td>68</td>
<td></td>
</tr>
</tbody>
</table>

Event contamination

- No news days
- 9 patent days
- One trademark day
Identification of rivals and suppliers

• Given the patent thicket & network externalities, horizontal rivals easy to identify

• Suppliers
  – Teardown reports
  – Announcements of supply contracts
Estimation methods

• To estimate the abnormal returns we use
  – the market model,
  – the mean return model,
  – the FF model
  – etc
• The Market Model:

\[ R_{it} = \alpha_i + \beta_i R_{mkt,t} + \epsilon_{it} \]

– Estimation window
  • Fixed (pre-iPhone)
  • Rolling (-250,10)

– Event window (0)
– Daily returns: CRSP (Datastream)
– Mkt portfolio = CRSP value-weighted marked index
Figure 1: AAPL market model beta
## Results:
Abnormal returns to news events

<table>
<thead>
<tr>
<th>Average abnormal mean return (t=0)</th>
<th>AAPL</th>
<th>NOK</th>
<th>MOT</th>
<th>ERIC</th>
<th>RIMM</th>
</tr>
</thead>
<tbody>
<tr>
<td>all events (n=74)</td>
<td>0.47%*</td>
<td>0.29%</td>
<td>-0.07%</td>
<td>-0.37%</td>
<td>-0.19%</td>
</tr>
<tr>
<td>abnormal volume events (n=22)</td>
<td>1.93%***</td>
<td>0.20%</td>
<td>-0.20%</td>
<td>-0.22%</td>
<td>-0.39%</td>
</tr>
</tbody>
</table>
Results:
Abnormal returns around the “important” news event day day

<table>
<thead>
<tr>
<th>Model</th>
<th>day-2</th>
<th>day-1</th>
<th>day0</th>
<th>day+1</th>
<th>day+2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market model, 2003-2004</td>
<td>-0.26%</td>
<td>-0.53%</td>
<td>1.93***</td>
<td>0.77%</td>
<td>-0.74%</td>
</tr>
<tr>
<td>Market model, (-250,-10) e</td>
<td>-0.23%*</td>
<td>-0.55%</td>
<td>1.92***</td>
<td>0.79%</td>
<td>-0.75**</td>
</tr>
<tr>
<td>Fama-French, 2003-2004</td>
<td>-0.11%</td>
<td>-0.57%</td>
<td>1.92***</td>
<td>0.74%</td>
<td>-0.80*</td>
</tr>
<tr>
<td>Mean return model, (-250,-)</td>
<td>-0.14%</td>
<td>-0.48%</td>
<td>1.81***</td>
<td>0.44%</td>
<td>-0.73**</td>
</tr>
<tr>
<td>Mean return model, 2003-2</td>
<td>-0.11%</td>
<td>-0.38%</td>
<td>1.86***</td>
<td>0.48%</td>
<td>-0.86%</td>
</tr>
</tbody>
</table>
Results:
Abnormal returns to patent applications

<table>
<thead>
<tr>
<th></th>
<th>aapl</th>
<th>nok</th>
<th>mot</th>
<th>eric</th>
<th>rimm</th>
</tr>
</thead>
<tbody>
<tr>
<td>day-1</td>
<td>0.01%</td>
<td>0.27%</td>
<td>-0.20%</td>
<td>0.31%</td>
<td>-0.03%</td>
</tr>
<tr>
<td>day0</td>
<td>0.02%</td>
<td>0.20%</td>
<td>-0.31%</td>
<td>-0.37%</td>
<td>-0.49%</td>
</tr>
<tr>
<td>day+1</td>
<td>-0.36%</td>
<td>0.05%</td>
<td>-0.27%</td>
<td>-0.16%</td>
<td>-0.03%</td>
</tr>
</tbody>
</table>

with signif. trading volume and no contamination

<table>
<thead>
<tr>
<th></th>
<th>aapl</th>
<th>nok</th>
<th>mot</th>
<th>eric</th>
<th>rimm</th>
</tr>
</thead>
<tbody>
<tr>
<td>day-1</td>
<td>0.29%</td>
<td>0.08%</td>
<td>-0.17%</td>
<td>0.68%</td>
<td>-0.78%</td>
</tr>
<tr>
<td>day0</td>
<td><strong>1.13%</strong>*</td>
<td>0.11%</td>
<td>0.37%</td>
<td>-0.50%</td>
<td>-0.93%</td>
</tr>
<tr>
<td>day+1</td>
<td>-0.03%</td>
<td>0.13%</td>
<td>-0.53%</td>
<td>-0.09%</td>
<td>-0.42%</td>
</tr>
</tbody>
</table>
Results: grants&trademarks

• Patent grants exhibit no significant reactions

-> all significant new technological information in applications

• Cf. Novelty and disclosure criteria for patentability

• Nor do trademarks exhibit significant reactions
Market value results

- Our results are likely to yield a lower bound for iPhone value
  - Information leaks to the market before news and patent applications are published
  - We use a tight event window
  - We use a tight screen for events
  - Contaminated events thrown out
  - We only consider “important” events
  - We use event day dollars
  - Our estimates reflect the situation at the end of 2009
## Results:

Value of iPhone $\approx$ $30$ bilj

<table>
<thead>
<tr>
<th>Model</th>
<th>(Sign) Events</th>
<th>Value ($\text{bilj}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market model</td>
<td>news</td>
<td>24.4</td>
</tr>
<tr>
<td>Market model with Fama-French</td>
<td>news</td>
<td>23.9</td>
</tr>
<tr>
<td>Mean return model</td>
<td>news</td>
<td>20.0</td>
</tr>
<tr>
<td>Mean return with fixed est. p</td>
<td>news</td>
<td>20.6</td>
</tr>
<tr>
<td>Market model</td>
<td>patent applications</td>
<td>7.8</td>
</tr>
</tbody>
</table>
## Results:

### Determinants of patent value

<table>
<thead>
<tr>
<th>Determinant</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backward cit</td>
<td>0.0018</td>
<td>(0.002)</td>
<td></td>
</tr>
<tr>
<td>Forward cit</td>
<td>-0.001</td>
<td>(0.002)</td>
<td></td>
</tr>
<tr>
<td>Time trend</td>
<td>-0.0087**</td>
<td>(0.003)</td>
<td></td>
</tr>
<tr>
<td>Claims</td>
<td>-0.0089*</td>
<td>(0.005)</td>
<td></td>
</tr>
<tr>
<td>Signif. Volume</td>
<td>0.0127*</td>
<td>(0.006)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-0.005</td>
<td>(0.004)</td>
<td></td>
</tr>
</tbody>
</table>
## Results:

### Value effects in supply chain

<table>
<thead>
<tr>
<th></th>
<th>pre-ann</th>
<th>ann</th>
<th>post-ann</th>
</tr>
</thead>
<tbody>
<tr>
<td>apple</td>
<td>0.0289***</td>
<td>0.1609***</td>
<td>0.0195***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.008)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>servicep</td>
<td>0.0019</td>
<td>0.0195</td>
<td>-0.0034</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.012)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>supplier</td>
<td>0.0012</td>
<td>0.0638***</td>
<td>0.0033</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.019)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.0044</td>
<td>-0.0370**</td>
<td>0.0011</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.008)</td>
<td>(0.004)</td>
</tr>
</tbody>
</table>
Conclusions

• We use an old method of valuation to new and old goals:
  – We use daily stock market return data to study valuation of innovation and intellectual property via iPhone case

• We separate important events from noise events by using stock market and internet activity data
Conclusions

• iPhone value is roughly $30bilj
  – 25% is due to iPhone-patents

• Patent applications rather than grants contain new, valuable information to the market

• In the supply chain, Apple captures most of the value
Conclusions

• To us, the method works pretty well
  – We find some significant results of plausible magnitude
    • The method provides a lower bound of valuation

• How well the method can be used in case of other (publicly traded) corporations?
  – Apple, after all, might constitute the best case for the method