Two Sided Markets with Substitution: Mobile Termination Revisited

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Mobile networks an example of two sided markets:
both subscribers and inward callers derive utility

- Mobile networks have relatively high fixed costs and low marginal costs
- Differential pricing of outgoing and incoming calls has led to regulatory concern and intervention
- Do regulators have sufficient knowledge to “rebalance” prices in an economically rational manner?
  - Usually have adopted a cost based measure to set termination prices.
  - Not based on economic welfare of end users

Previous literature implications
- Even in highly competitive mobile markets each operator will set “monopoly” termination price
  - Profits will be competed away to subsidize mobile subscribers
- Competitive bottleneck means equilibrium termination charges are “too high”
However, optimal termination charges are above cost since fixed line callers receive a positive externality by being able to call additional mobile subscribers

- Additional welfare is virtual price minus actual price for that call: \( p_f^* > p_f \)
- Hausman estimated lower bound virtual price in Australia to be A$1.07 compared to FTM price of $0.33
- Hausman found that new mobile subscribers had approximately the same average amount of incoming calls as existing subscribers
- Additional externality arises from MTM calls

- Contribution of this paper: FTM callers are also likely to be mobile subscribers
  - In Australia penetration rate is above 70%
  - Mobile subscribers can substitute MTM calls for FTM calls
Main Results of Paper

- Analytical results of paper
  - Mobile operators will set termination charge below the monopoly level
  - Equilibrium termination charges are not necessarily too high compared to welfare maxing termination price
  - Additional Network externalities imply socially optimal charges can be further above costs

- Calibrate model to Australian data
  - Allowing for MTM to substitute for FTM causes equilibrium termination charge to decrease below monopoly level
  - Model predicts $0.25 somewhat above observed level of $0.21, but this amount had decreased due to previous regulation
    - Bottleneck theory predicts $0.33
  - Find socially optimal termination charge to be $0.18 well above cost of $0.05 cents cost of termination
• Use cost based regulation leads to lower welfare that unregulated equilibrium level.

• Model specification:
  o Non-mobile subscriber can only make FTM calls at price $p_f$ to reach someone “on-the go” with utility $v_f(p_f)$
  o Mobile subscribers can also make a MTM call at price $p_m$ and achieves utility $v(p_f, p_m)$
  o For a person on the go to another person on the go a MTM call is made with utility $v_m(p_m)$
  o We assume a higher own price elasticity of FTM calls when you can substitute to MTM:
    \[
    \left| \frac{\partial q_f}{\partial p_f} \right| > \left| \frac{\partial q_f}{\partial p_f q_f} \right|
    \]
  o Mobile Subscriber benefits—vary across the population
    ▪ Make MTF calls
    ▪ Make MTM calls
- Ability to be reached
- Ability to receive calls
  - Benefits have a distribution function $G$ across population with hazard function $\mu = g/(1-G)$
  - Non-subscribers get utility from FTM calls of $Nv_f$ where $N$ is number of mobile subscribers
  - Mobile subscribers get utility: $b - r_i + N(v + v_m)$ where $b$ is exogenous benefit of subscribe (from above), $r_i$ is subscription price, an last term is utility from calling people on the go
  - Assume homogenous Bertrand price competition with MTM calls price set at marginal cost with 2 part tariff giving this solution.

- Analysis for the general case
  - Rental price is $r = f - \pi_r$ where $f$ is the cost per subscriber and $\pi_r$ is FRM termination profit which lower subscription price or subsidizes handsets.
- Assuming all “excess” termination profits are competed away
  - Critical value for people who subscribe is $b^* = r - (v - v_f + v_m)N$ so demand for mobile is $N = 1 - G(b^*)$
  - Network effects cannot be too strong or will tip to 100% penetration.
  - We assume will not happen and satisfied in calibrated model.
- Number of mobile subscriber increases with FTM termination charge $a$ through 2 effects:
  - (1) higher profits per subscriber leads to lower subscription prices—“waterbed effect” and
  - (2) Higher $a$, the termination charge, leads to higher price of FTM calls so more people subscribe so they can substitute to MTM calls. Effect not included in models to date.
- Let $a_M$ be profit maximizing (monopoly) termination rate where no MTM substitution exists (current
literature) and let equilibrium termination charge with MTM substitution be $a_N$ with $N$ held fixed, and $a^*$ be equilibrium termination charge and $c$ be termination cost

- **Prop 1**: $c < a^* < a_N < a_M$ so allowing for MTM substitution lowers both FTM termination charge and retail price
  - Result occurs because FTM demand is more elastic in presence of MTM substitution holding penetration constant and penetration increases with mobile termination charge so $a^* < a_N$

- Compare to termination charges that maxes SWF:

$$W = \int_{b^*}^{\overline{b}} (b - r + N(u + v_m) + (1 - N)v_f)g(b)\,db.$$  

where first term is utility for mobile subscribers and second term is for non-mobile subscribers. After substitution we max:
• **Prop 2:** Welfare maxing termination charge $a_w$ is above cost $c$. The equilibrium termination charge $a^*$ can be either higher or lower than $a_w$.
  
  o Need it to exceed cost to subsidize mobile subscription so previous regulation as in UK is not correct.
  
  o Empirical evidence that UK regulation increases prices and decreases subscriptions:
• Allowing for MTM substitution negates key result from earlier literature that \( a^* > a_W \) is no long true.
  
  - Before \( a' = a_M \) and for \( a_M - \varepsilon \) for small \( \varepsilon \) always increased welfare since to first order \( \pi_T \)
    (envelope theorem) remained unchanged but FTM prices decreased.
○ Now an $\varepsilon$ change from $a^*$ decrease the number of mobile subscribers since they have less need to avoid high FTM prices.
  - Decreasing penetration decreases welfare because of the positive externality on others who can call them: virtual price is higher than equilibrium price, $p_f^* > p_f$
  - “Monopoly outcome” is eliminated by MTM competition
  - However, even previous literature did not demonstrate that setting mobile termination charge to cost, $c$, increased welfare
  - My calculations for Australia demonstrated otherwise
○ In “mature market” with penetration at 100% question is without subsidy would penetration decrease?
  - If not (mobile is a “necessity) then $a_w = c$
  - However, unlikely to be the situation.
  Compare to US where we have RPP instead of CPP so no termination subsidy exists
- Despite highly competitive industry and low prices we have penetration at around 75%.
Calibrated Model

• Use Australian data for 2004. 3 large carriers, Telstra, Optus, and Vodafone with 1 smaller carrier
  o High degree of competition. ACCC says that neither Optus nor VOD earned cost of capital but no barriers to expansion.
  o Parameters from ACCC report: \( N = 0.72, p_f = 0.33, p_m = 0.10 \) (our estimate), \( a = 0.21, r = 22.00 \) per month, \( Q_m/Q_f = 2.6 \) (In RPP countries such as US and HK ratio is near 1.0)
  o ACCC (as did Offcom) use \( E_f = 0.6 \) which is inconsistent with monopoly termination claim
    ▪ We use 1.3 but also use a range of elasticities
    ▪ Our model can treat inelastic demand while previous models cannot
  o Additional assumptions:
    ▪ ratio of FTM to MTM calls from home when both are free (or same price) is set to 4.0
- Cross price elasticity of demand of FTM calls is 0.5 of own price elasticity
- Elasticity of mobile penetration is 0.55 (Hausman (1997) and (2002))
- We consider ranges of these variables

- For now we use quadratic utility and linear demand along with a uniform distribution
  - Solve model and find termination subsidy is about $4.11 per month. (Within “close” range of actual termination profit per subscriber)
  - Equilibrium termination charge from model is $0.25 while observed amount is $0.21 but that had been reduced due to prior regulation.
    - Monopoly model predicts charge of $0.33 well above the observed value.

- We now vary termination charge and find:
  - Increase in termination charge increases penetration since it allow a subscriber to use MTM and avoid higher FTM price
Penetration is maximized at $a = 0.30$ since high FTM prices (above profit maxing level) encourage more subscription.

Welfare maxing level is $a_w = 0.18$, which is lower than equilibrium but much higher than cost of $0.05$.

Cost based $W$ is lower than market based $W$.
- Termination rate would need to be about $0.30$ to get same $W$ as cost based rate
- Interesting at this termination rate you approximately maximize penetration
Figure 1: Welfare, Penetration Rate and Termination Profits

$W$ = Welfare (normalized)
$N$ = Penetration rate
$\pi_I$ = Termination profits in the absence of substitution
$\pi_M$ = Termination profits with substitution

16
Sensitivity analysis does not lead to significant changes
  o Used log-logistic distribution (like log normal)
    ▪ Welfare maxing $a_w = $0.238 even closer to equilibrium $a = $0.25 value
    ▪ Maximum penetration is at $a = $0.30
  o Original model major changes:
    ▪ if FTM own price elasticity is 0.6 (ACCC value and Offcom value) then $a_w = $0.32 which exceeds current observed value by over 50%
    ▪ If FTM own price elasticity is 2.0 then $a_w = $0.14. Note still much higher than cost estimate.
    ▪ Can find combinations of parameters where equilibrium termination charge is too low—below welfare maxing price
• **Conclusions and future research**

  o Regulator “monopoly termination view” misses 2 important points:
    - (1) Some or all of termination profit used to lower subscription prices, which is the **two sided market** effect.
      - Leads to increased utility for both mobile subscribers and for fixed lined caller who can now reach people on the go. New subscribers are like “new goods”—Hausman (1997)
    - (2) MTM can substitute for FTM.

  • Allowing for substitution the monopoly termination implication of being “too high” no longer holds true.
    o In Australia using regulatory elasticities we find monopoly termination rate is much higher than observe market determined termination rate so ignoring MTM substitution is probably incorrect
Market determined termination rate is considerably closer to welfare maximizing termination rate than a cost based rate. Market determined rate leads to higher welfare than cost based rate for all reasonable parameter values except when no subscription margin elasticity exists.

- However, difference here cannot be large because MTM substitution exists for nearly everyone.

- Policy recommendation: cost based termination charge is incorrect.
  - Consumer welfare is higher with market determined outcome for rates
  - While a small decrease may increase welfare it is beyond the ability of regulators to determine the optimal rate (even if they did PP&E)

- Future research: have used log-logistic distribution and would like to combine it with more general demand system.
o Hope to use a 2-level CES system with bottom level the choice between FTM and MTM calls with top level decision to call someone on the go given price index from lower level
o Will be a second order flexible demand system given the 2-good lower level choice situation.