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:
  - Non-mobile subscriber can only make FTM calls at price p_f to reach someone “on-the go” with utility $v_f(p_f)$
  - Mobile subscribers can also make a MTM call at price p_m and achieves utility $v(p_f, p_m)$
  - For a person on the go to another person on the go a MTM call is made with utility $v_m(p_m)$
  - We assume a higher own price elasticity of FTM calls when you can substitute to MTM:

$$\left|\frac{\partial \overline{q}_f}{\partial p_f}\frac{p_f}{\overline{q}_f}\right| > \left|\frac{\partial q_f}{\partial p_f}\frac{p_f}{q_f}\right|,$$

  - 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 $r = f - \pi_T$ where f is the cost per subscriber and π_T 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:

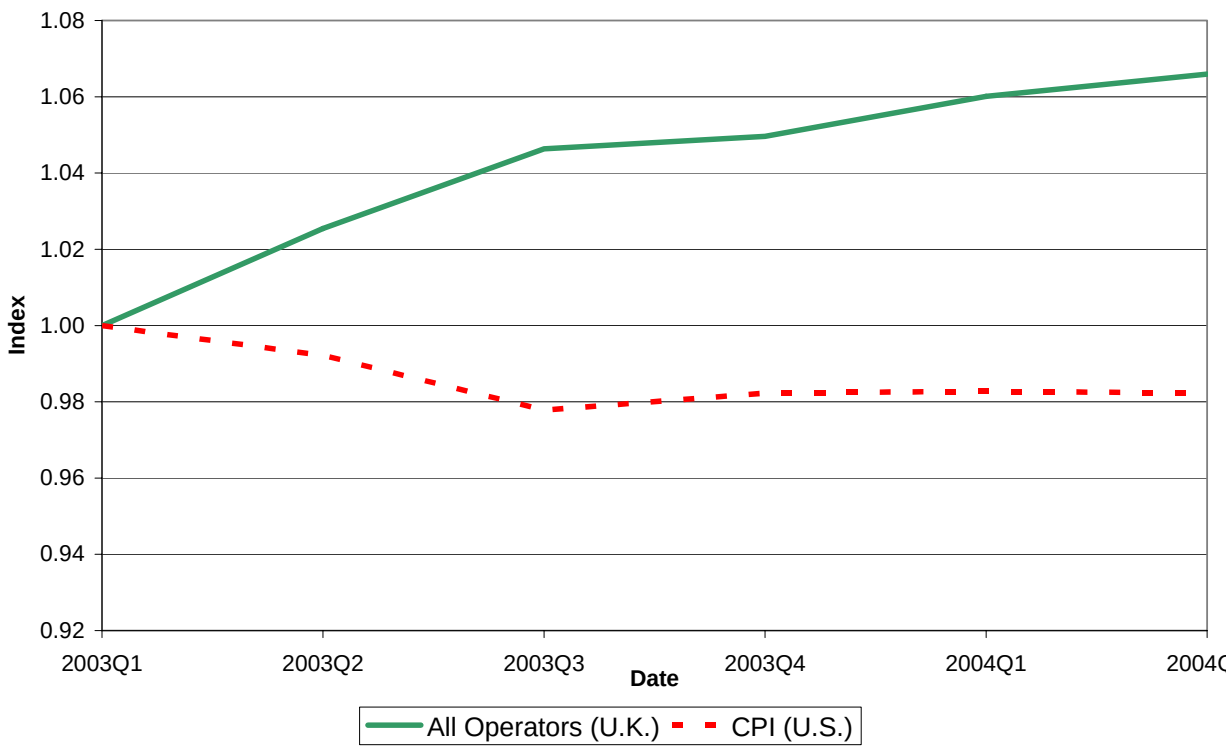
$$W = \int_{b^*}^{\bar{b}} \left(b - r + N\left(v + v_m\right) + \left(1 - N\right) v_f\right) g\left(b\right) db.$$

where first term is utility for mobile subscribers and second term is for non-mobile subscribers. After substitution we max:

$$W = \int_{b^*}^{\bar{b}} (b - f + G\pi_M + (1-G)\pi_C + (1-G)(v + v_m) + Gv_f)\, g(b)\, db,$$

- 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.
  - Need it to exceed cost to subsidize mobile subscription so previous regulation as in UK is not correct.
  - Empirical evidence that UK regulation increases prices and decreases subscriptions:

Figure 1: Comparison of Indexed Wireless Prices for U.S. and U.K



- 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 ε always increased welfare since to first order π_T (envelope theorem) remained unchanged but FTM prices decreased.

- Now an ε 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%.

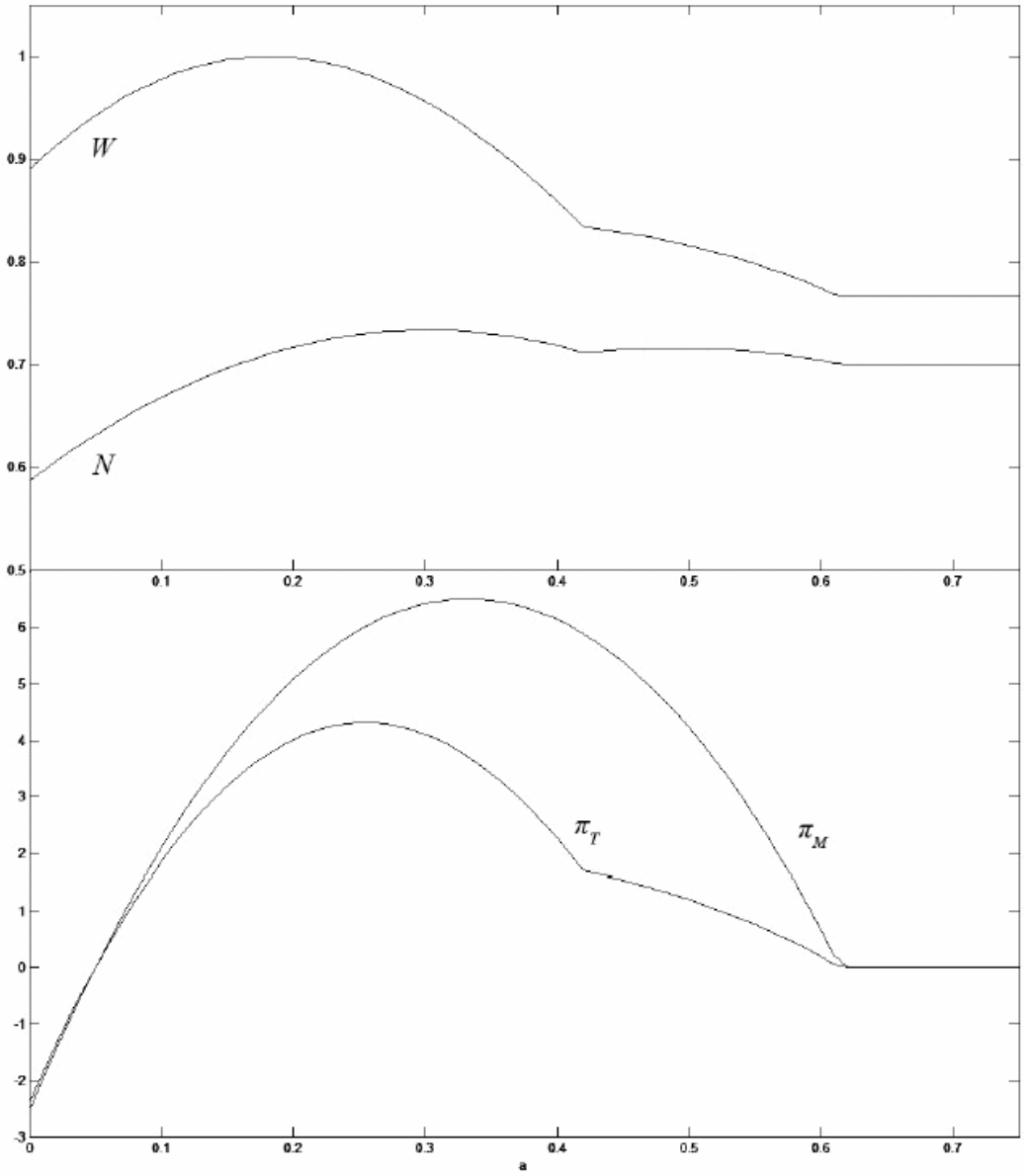
Calibrated Model

- Use Australian data for 2004. 3 large carriers, Telstra, Optus, and Vodafone with 1 smaller carrier
  - High degree of competition. ACCC says that neither Optus nor VOD earned cost of capital but no barriers to expansion.
  - 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)
  - 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
  - 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
π_M = Termination profits in the absence of substitution
π_T = Termination profits with substitution

- Sensitivity analysis does not lead to significant changes
  - 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
  - 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**
    - 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.
    - 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 that 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.

- 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
- Will be a second order flexible demand system given the 2-good lower level choice situation.