Blockchain Disruption and Smart Contracts

Outlines

I. Introduction
   1. Blockchain: distributed consensus, tamper-proof
   2. Observable aggregate service activity
   3. Enhance competition and foster collusion (*)
   4. Related Literature: Further Discussion
      a. Central banks' digital currencies – Yermack (2017)
      b. Mining pool formation and contracts – Baldimtsi et al. (2017)
      c. Cost of 1.5-2 percent of intermediated assets – Philippon (2016)

II. Blockchain and Smart Contracts
   1. Decentralized Consensus: cheaper, less risky
   2. Smart contracts: digital contracts, contingent terms, self-enforcing, automated execution. Greater contractibility and enforceability
   3. Information in D.C. is all public – unintended outcomes (Hershleifer effect)
   4. Applications in F.I. (Trusted Payments, Trade Finance, Exchange)

III. Traditional Model
   1. Setup
      a. Risk-neutral, infinite time and discrete, $t = 1, 2, \ldots$, discount factor δ
      b. Every t w/$p=\lambda$, a unit of buyers show up, with a unit goods demand
      c. Buyer live for one period
      d. Three long-lived sellers (A, B, C) produce and sell goods, either authentic or fraudulent. production cost = k
      e. In t=0, A, B are authentic incumbents. C is the entrant
      f. C knows its type, C is authentic with $p=\pi$ (C's reputation)
      g. In each t, each sell has its random quality $q=(q_a,q_b,q_c)$ iid, which is EU of buyers when delivery.
      h. q_i in [q-lower,q-upper], k < q-lower
      i. $q=(q_a,q_b,q_c)$ is public information and realized at the beginning of each period.
      j. C can enter the market by paying and small cost $\varepsilon > 0$, enter C enters if he can make profit > 0
   2. Assumption 1: No contingent on service delivery. Each seller can only observe his own buyers and its own transaction.

3. Bertrand Completion and Entry of C
    a. C enters if $\pi q_c >= \max\{q_A, q_B\}$, q-lower > πq-upper
    b. In traditional world, there is still rooms for improvement.
    c. Welfare and Surplus

$$\Pi_{buyer} = \mathbb{E}_s \left[\sum_{t=s+1}^{\infty} \delta^{t-s} \mathbb{I}_t \left(\min\{q_{A_t}, q_{B_t}\} - \mu \right) \right] = \frac{\delta\lambda}{1-\delta} \mathbb{E} \left[\min\{q_A, q_B\} - \mu \right]$$

$$\Pi_{total} = \mathbb{E}_s \left[\sum_{t=s+1}^{\infty} \delta^{t-s} \mathbb{I}_t \max\{q_{A_t}, q_{B_t}\} \right] = \frac{\delta\lambda}{1-\delta} \mathbb{E} \left[\max\{q_A, q_B\} \right].$$

4. Collusive Equilibria
    a. $f(q_A, q_B)$: market allocation function,
    b. M_1: seller's expected payoff, M_2: that in punishment phase, M_3:Gain from deviation.
    c. Threshold δ: the minimal δ maintaining collusion

$$\frac{\lambda\delta\left(1-\delta^T\right)}{1-\lambda\delta-(1-\lambda)\delta^{T+1}} \geq \frac{M_3}{M_1-M_2} \tag{8}$$

where $M_1 = E[f(q)(q-\mu)], M_2 = E[(q_i - q_{-i})^+], M_3 = \max_q\{(1-f(q))(q-\mu)\}, f(q_i) = E_{q_{-i}}[f(q_i, q_{-i})]$.

IV. Model with Blockchain Disruption (Contrary to Assumption 1)

1. Smart Contract between A and B, Observable service activities on BC
2. Contingent terms on delivery, C can set separating price.
3. C always in, thus improving consumer surplus and welfare

$$\Pi_{buyer} = \mathbb{E}_s \left[\sum_{t=s+1}^{\infty} \delta^{t-s} \mathbb{I}_t \left(q^{(2)} - \mu \right) \right] = \frac{\delta\lambda}{1-\delta} \mathbb{E} \left[q^{(2)} - \mu \right] \tag{9}$$

$$\Pi_{total} = \mathbb{E}_s \left[\sum_{t=s+1}^{\infty} \delta^{t-s} \mathbb{I}_t q^{(1)} \right] = \frac{\delta\lambda}{1-\delta} \mathbb{E} \left[q^{(1)} \right]. \tag{10}$$

4. Enhanced Collusion. Smaller δ can trigger collusion
5. Combined effect: Higher Social Welfare, Low CS.
6. Reduce Measures: Separation of Usage and Consensus Generation, Blockchain Competition, Noise Injection.

V. Information Asymmetry and Private Qualities

1. CS = SW = E[q] – k in Tradition World
2. Smart Contracts resolve I.A. (whether qualities are private)