The Economics of Platforms in a Walrasian Framework

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Motivation

- A successful platform needs to intermediate between buyers and sellers.
- We are interested in platforms where buyers and sellers care about the composition of the platform's users.
  - causing a potential 'externality' arising from one agent's platform choice on other agents' willingness to join the same platform.
- A credit card company must attract both consumers and merchants.
- Dark pools and exchanges must attract buyers and sellers.
- Internet service providers (ISPs) need to attract content producers and users.

Example: M-Pesa

- Payment system for both consumers and merchants.
- 20 million M-Pesa users in Kenya.
- It is used to pay merchants and to transfer money to other users.
- Given that the a user's benefit to using M-Pesa is conditional on the number of other consumers and merchants:
  - How much should a consumer pay?
  - How much should a merchant pay?
  - How does the payment depend on M-Pesa's composition of users?

Questions to answer

- In the context of multiple competing platforms is there a Walrasian equilibrium?
- Is the Walrasian equilibrium efficient?
- Is there a role for regulation due to a possible network externality?
- Are these "externalities" something which (only) regulation can deal with?
- How do changes in wealth affect prices and subsequently user's welfare?

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Solution

- Answer: Under certain assumptions, general equilibrium theory can answer these questions—in a manner suggested by Meade (1952) and Arrow (1969).
  - We can "internalize" the network externality through ex ante contracting.
  - Use "Firms as Clubs" (Prescott and Townsend (2000) and General Equilibrium theory.

Roadmap

- Outline the model.
- Examples of the environment equilibrium.
- Comparative statics: Testing how the equilibrium changes with changes in costs, wealth, and distribution of user types.
- Outline model extensions.
- Conclusion.

Set-up

- There are two agent types—buyers (A) and sellers (B).
- Buyers and sellers can trade only on a platform.
- Buyers and sellers care about the composition of the platform's users.
- Buyers and sellers each have some capital endowment (κ).
- There is a single intermediary that connects agents to platforms.

Agent's utility function

- An agent wants a higher **ratio** of agents of the other type, and **larger** platforms.
- A buyer's (A, i) utility function is:

$$U_{A,i}(N_A, N_B) = U_A(N_A, N_B) = \begin{cases} 0 & \text{if } N_A \text{ or } N_B = 0 \\ \left[\left(\frac{N_B}{N_A}\right)^{\gamma_A} + N_B^{\epsilon_A}\right] & \text{else} \end{cases}$$

- Where $\gamma_A, \gamma_B, \epsilon_A$ and $\epsilon_B > 0$
- Symmetrically, the seller's (B, i) utility function is:

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Cost of making a platform

- A platform is costly to manufacture, increasing in the number of users of each type, and increasing in the set of possible connections.

$$C(N_A, N_B) = \begin{cases} 0 & \text{if } N_A = 0 \text{ or } N_B = 0 \\ c_A N_A + c_B N_B + c N_A N_B + K & \text{else} \end{cases}$$

- Where $c_A, c_B, K \geq 0$ and $c > 0$.
- Larger platforms are more than proportionally more expensive ($c > 0$)

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Agent's maximization problem

- Agent type (T), subtype (i) buys contracts $b_T(N_A, N_B)$ to join a platform of size and composition (N_A, N_B), subject to:
  - their wealth constraint
  - joining one platform.

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- Key tool to convexify commodity space: agents do not buy discrete numbers of contracts instead agent's buy probabilities to join a platform.

Agent's maximization problem

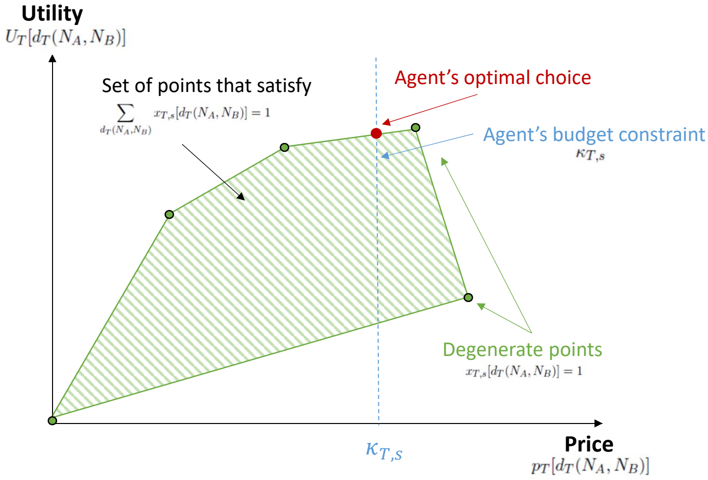
- Agent (T, i) takes prices $p[b_T(N_A, N_B)]$ as given and solve the following maximization problem:

$$\max_{x_{T,i}} \sum_{N_A, N_B} x_{T,i}[b_T(N_A, N_B)] U_T[b_T(N_A, N_B)] \tag{1}$$

$$\text{s.t.} \sum_{N_A, N_B} x_{T,i}[b_T(N_A, N_B)] p[b_T(N_A, N_B)] \leq \kappa_{T,i} \tag{2}$$

$$\sum_{N_A N_B} x_{T,i}[b_T(N_A, N_B)] = 1 \tag{3}$$

Agent's maximization problem—graphical illustration



Intermediary's problem

- The intermediary maximizes the number of platforms $y(N_A, N_B)$ to produce for the given prices $(p[b_T(N_A, N_B)])$ for each position in the platform.
- The intermediary's profits are equal to the number of contracts it sells multiplied by the price of the contract minus the cost of the capital input.

Intermediary's problem

- The intermediary's FOC w.r.t. to $y(N_A, N_B)$ is:

$$C(N_A, N_B) \geq p[b_A(N_A, N_B)] * N_A + p[b_B(N_A, N_B)] * N_B \quad (4)$$

  - **This condition requires the payments/memberships the platform recieves must cover all of the platform's costs.**

Market clearing

- The demand for each contract for each type must equal the supply of that contract.

$$\sum_i x_{T,i}[b_T(N_A, N_B)] = y_T(b_T(N_A, N_B) \equiv N_A \times y(N_A, N_B) \; \forall N_A, N_B, \; T \in$$

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Competitive equilibrium

- A competitive equilibrium in this economy is $(p, x, y) \in L \times X \times Y$ such that
  - For given prices, the allocation solves the consumer and platform maximization problems.
  - All markets clear: the demand for each contract equals the supply of each contract.
  - Active platforms are populated by numbers of buyers and sellers as anticipated (stipulated).

Summary of results

- A competitive equilibrium is Pareto optimal.
- Any Pareto optimal allocation can be achieved with transfers between agents:
  - The first and second welfare theorems hold in our modified environment
- The endogenous pricing internalizes the effect of changing the composition of the platform—overcoming any network externality—as in Arrow (1969)

Simple example—identical preferences and wealth

- Consider a platform with 2 subtypes of buyers, and 2 subtypes of sellers
- There is a measure 1 of each type, a measure 0.5 of each subtype
- Each agent is equally wealthy

Equilibrium platforms

Platform Size (N_A, N_B)	Number of Platforms Created $y(N_A, N_B)$	Cost of Production $C(N_A, N_B)$
(2,2)	0.5	8

Equilibrium user utility and platform choice

Type (T, s)	Wealth $(\kappa_{T,s})$	Platform Joined (N_A, N_B)	Price of Joining $p(d_T[N_A, N_B])$	Pr(joining) $x_{T,s}(d_T[N_A, N_B])$	Utility on Platform $U_T(N_A, N_B)$
A,1	2	(2,2)	2	1	2.41
A,2	2	(2,2)	2	1	2.41
B,1	2	(2,2)	2	1	2.41
B,2	2	(2,2)	2	1	2.41

The effect of a single richer subtype

- Let subtype $(B, 2)$ be markedly richer than other types
- $(B, 2)$ will "sponsor" larger platforms—lower prices for Type (A)

Platform Size (N_A, N_B)	Number of Platforms created	Cost of Production
$(3, 2)$	0.25	11
$(1, 2)$	0.25	5

Type (T, i)	Wealth	Platform joined (N_A, N_B)	Price of joining	Pr(joining)	Utility on Platform	Expected Utility
$A, 1$	1.37	$(3, 2)$	1.37	1	2.23	2.23
$A, 2$	1.64	$(3, 2)$	1.37	0.5	2.23	2.53
		$(1, 2)$	1.91	0.5	2.8	
$B, 1$	1.54	$(1, 2)$	1.54	1	1.7	1.7
$B, 2$	3.45	$(3, 2)$	3.45	1	2.96	2.96

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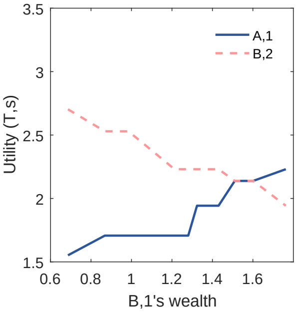
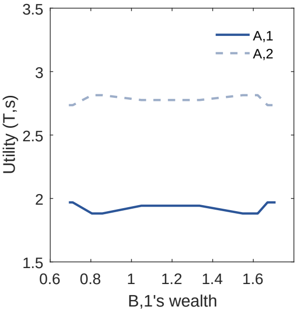
How does the equilibrium change as we redistribute wealth? Redistributing wealth *across*- and *within*- agent type.

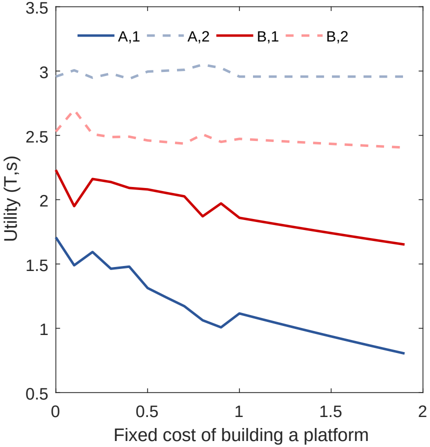


(A) **Across**: Transferring wealth from (A,2) to (B,1)

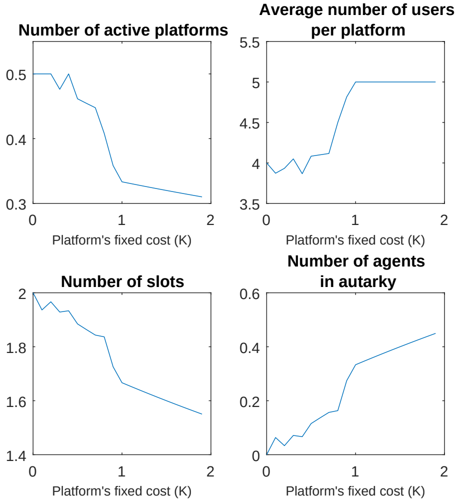


(B) **Within**: Transferring wealth from (B,2) to (B,1)

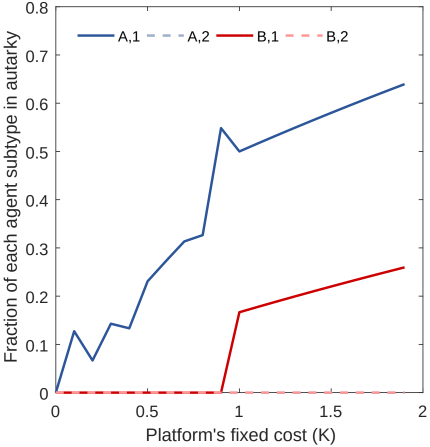
How does the equilibrium utility change as we increase the fixed cost of building a platform?



How does the equilibrium characteristics change as we increase the fixed cost of building a platform?



How does participation by subtype change as the fixed cost of building a platform rises?



Extensions (in the paper)

- User heterogeneity
  - The base model only allows for heterogeneity within users by wealth.
  - The model is extended (in the paper) to allow different user preferences within type—for example, some agents really like being on larger platforms.
- Multihoming
  - The base model only allows agents to join one platform.
  - The model is extended to allow agents to join multiple platforms.

Conclusion

- Even when agents' preferences are dependent on a platform's composition – the competitive equilibrium is efficient.
  - The endogenous pricing internalizes the benefits form changing a platform's composition.
- Using the GE framework we can examine how changes in wealth, preferences, affect the resulting equilibrium.
- A decrease in the cost of creating platforms may help the poorest agents the most.
- Our framework has limitations:
  - We assume no platform has any market power.
  - Our model is purely static – no consideration for entry or innovation in the space of platforms.