An agent-based model of platform competition in the Food Delivery Industry

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Outline

Motivation: The rise of the “platform economy”

Value Rank ▼	Company	Market Value	Sector
1	Apple	$921 bil.	Technology
2	Amazon.com	$765 bil.	Retailing
3	Alphabet	$750 bil.	Technology
4	Microsoft	$746 bil.	Technology
5	Facebook	$531 bil.	Technology
6	Berkshire Hathaway	$492 bil.	Financials
7	JPMorgan Chase & Co.	$388 bil.	Financials

As of 5/21/2018

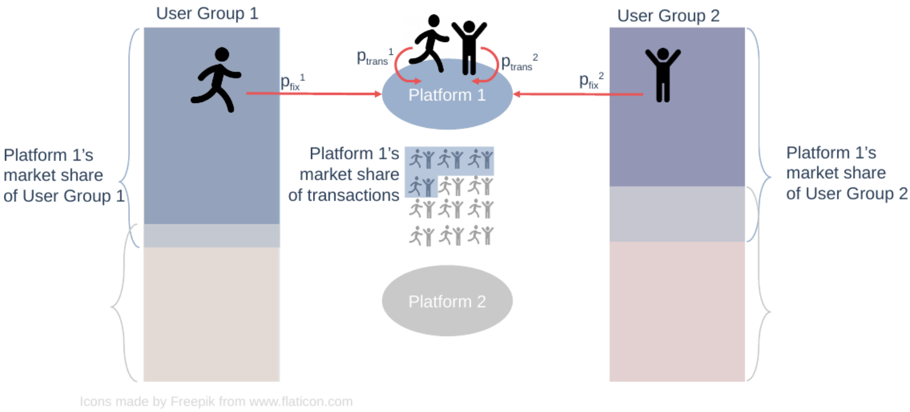
SOURCE: Fortune 500

Controversies around “platformization”

- massive data collection
- negative ecological impact (energy, hardware)
- precarious working conditions
- concentration of power in the hands of few platforms

▷ How exactly do these mechanisms of power concentration work?

Two-sided industries – an economical framework



▷ **network effects** as characteristic feature of two-sided industries

History of theoretical approaches at a glance

Arthur (1989): Technology competition under increasing returns

- including network size into utility calculation and adoption decisions with regard to technologies
- different return regimes change adoption processes fundamentally (e.g. with regard to path-dependency)

Rochet and Tirole (2003): conceptualization of “two-sidedness”

- platforms as intermediaries between a supply- and a demand-side
- equilibrium model of optimal prices under competition and monopoly
- starting point for further equilibrium models, e.g. Evans and Schmalensee (2008), Armstrong (2010) ...

Heinrich and Gräbner (2017): agent-based model of two-sided industries

- allows for studying different decision making rules and more than two platforms

What determines concentration in digital two-sided industries?

Theoretically known factors which decrease concentration in multi-sided industries:

- weak or asymmetric indirect network effects
- strength of direct network effects
- multi-homing
- market-size
- compatibility of different platforms
- strong innovation dynamics

(Budzinski and Kuchinke (2018), Haucap and Stühmeier (2015))

Research goal

Overarching research goal

Development of an empirically validated agent-based model to understand drivers of concentration and diffusion of digital platforms in multisided industries

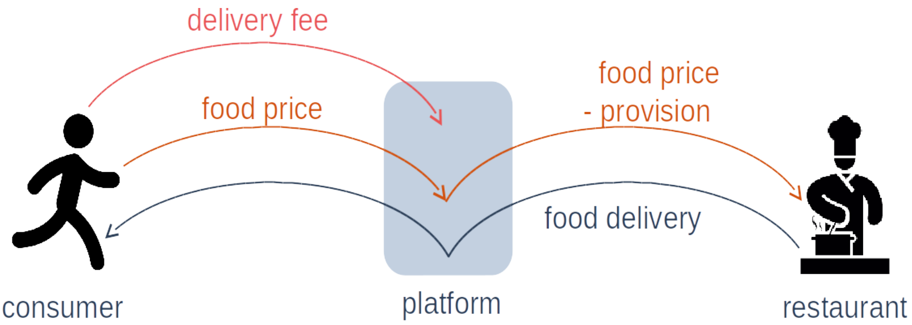
Subgoal

Development of a simple model reproducing basic features of concentration

The case of the Food Delivery Industry

Definition: Food Delivery Platform

- provides consumers with meals from partner restaurants
- offers to handle the delivery process



Agent types

Consumers:

- may carry out transactions (order food)
- in case of transaction: decide for a platform to use

Restaurants:

- decide which platform to sign up with

deliveroo

Platforms:

- will set restaurants commission and consumers delivery fee
- current state of the model: constant prices

Parameters and variables

Exogenous simulation parameters:

- N number of time steps
- n_c total number of consumers
- n_r total number of restaurants
- n_{pf} total number of platforms
- n_{trans} number of transactions carried out per time step

Observed variables:

- $n_r^{pf}(t)$ number of restaurants at each platform
- $n_{trans}^{pf}(t)$ number of transactions carried out via each platform
- $n_p^{pf}(t)$ number of platforms

Simulation steps

In each time step $t = 1, \ldots, N$ following steps are taking place:

1. Pick n_{trans} random consumers
2. Iterate over chosen consumers:
   ▷ each chosen consumer places an order
3. Iterate over all restaurants
   ▷ each restaurants updates its platform memberships
4. Update observed variables at time t for all platforms:
   - $sh^{pf}_{trans}(t) \in [0, 1]$: share of transactions carried out via *pf* at *t*
   - $n^{pf}_{r}(t)$: number of member restaurants of *pf*
   - $n^{pf}_{mult}(t)$:number of multihoming restaurants *pf*

Consumer iterations

Parameters of a consumer *c*

w_c: weight of network utility component

- Interpretation: How important is a big choice of restaurants to her?

Steps of a single transaction (placing an order)

1. evaluate expected returns of all platforms
2. choose best platform for the transaction (in case of equality: randomly choose one of the best platforms)

Expected returns of choosing platform *pf* at time *t*

$$ret_{c,t}(pf) = \underbrace{a_c^{pf} - p_{c,t}^{pf}}_{\text{platform-intrinsic net returns}} + \underbrace{w^c \cdot n_r^{pf}(t)}_{\text{network-based returns}}$$

Restaurant iterations

Parameters of a restaurant r

w_r: weight of network utility component
c_f^r: fixed costs of using a platform
ret_{min}^r: expected returns threshold to join a platform

Steps of an updating process

1. Evaluate expected returns of membership of all available platforms
2. leave all platforms with negative expected returns
3. join all platforms with exp. returns exceeding ret_{min}^r

Expected returns of membership with platform pl at time t

$$ret_{r,t}(pf) = \underbrace{a_r^{pf} - c_f^r}_{\text{platform-intrinsic net returns}} + \underbrace{w^r \cdot sh_{trans}^{pf}(t-1) \cdot (1 - p_{t,r}^r)}_{\text{network-based returns}}$$

Platform iterations

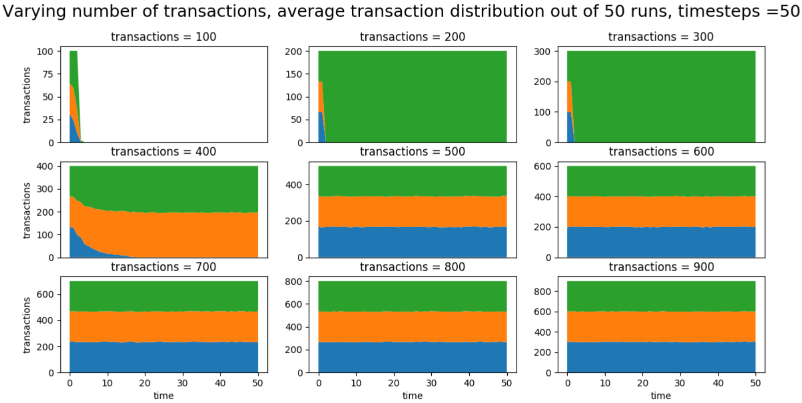
Parameters of a platform *pl*

$p^{pf}_{c,t}$	consumers' transaction fee
$p^{pf}_{r,t} \in [0,1]$	restaurants' commission per transaction
a^{pf}_{c}	consumers' platform-intrinsic returns (e.g. usability...)
a^{pf}_{r}	restaurants' platform-intrinsic returns (e.g. increased popularity)

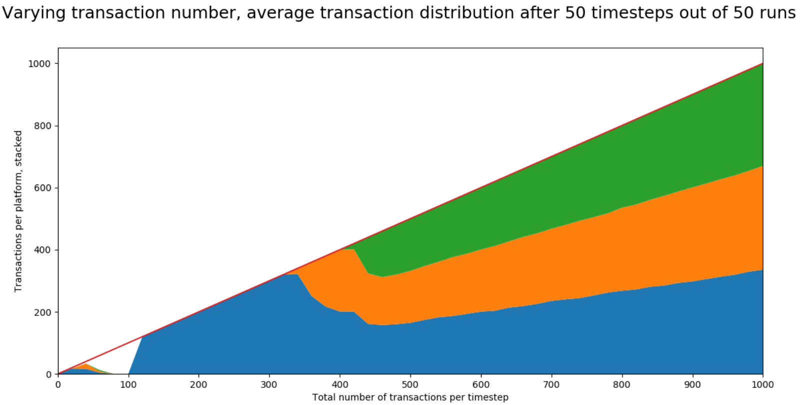
- current model: no iteration of platforms yet
- intended: price adaptations via learning algorithm

Preliminary results

▷ number of existing platforms increases with number of transactions



Preliminary results



Outlook

Next steps:

- variable prices, i.e. platforms apply learning strategies to adapt prices
- endogenous network effects, i.e. consumers and restaurants evaluate past transactions via a platform instead of a fixed network returns component in their returns function
- empirical validation: ongoing data collection of Food Delivery platforms in Berlin and Madrid via webscraping