

Competitive Markets for Personal Data

Simone Galperti
UCSD

Tianhao Liu
Columbia

Jacopo Peregó
Columbia

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Consumers supply a crucial input for modern economy: their **personal data**

Yet, they often have **limited control** over how and by whom their data is used:

- “Expropriation” and barter, common practice in the industry (FTC '15)
- This may lead to inefficiencies and inequality (Seim et al. '23)

New legislation gives consumers more control over their data (GDPR, CCPA, ...)

- Lays foundations upon which **data markets** could emerge

What properties would these markets have, and how should they be designed to promote desirable outcomes?

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“GE meets ID”

- Consumers own their data and can sell it to a platform
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2. Propose three solutions to this market failure:

- Data unions; Data taxes; Lindahl prices

model

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Two periods: 1. Data markets are open 2. Product market is open

The consumers and the platform trade data records at prices $p = (p(\omega))_{\omega \in \Omega}$, which they take as given

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- If type- ω consumer doesn't sell her record, she gets reservation utility $r(\omega)$

Given acquired database q , platform acts as **information designer**: (as in BBM)

- It sends merchant signal about each consumer in database
- Given signal, merchant charges each consumer a fee a
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The **payoffs** in period 2 are:

$$\text{Consumer's:} \quad u(a, \omega) = \max\{\omega - a, 0\}$$

$$\text{Merchant's:} \quad \pi(a, \omega) = a \mathbb{1}(\omega \geq a)$$

$$\text{Platform's:} \quad v(a, \omega) = \gamma_u u(a, \omega) + \gamma_\pi \pi(a, \omega)$$

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Info-design problem equiv to platform choosing mechanism $x : \Omega \rightarrow \Delta(A)$ s.t.

$$\begin{aligned} V(q) = & \max_{x: \Omega \rightarrow \Delta(A)} \sum_{\omega, a} v(a, \omega) x(a|\omega) q(\omega) \\ \text{s.t. } & \forall a, a': \sum_{\omega} \left(\pi(a, \omega) - \pi(a', \omega) \right) x(a|\omega) q(\omega) \geq 0 \end{aligned} \quad (\mathcal{P}_q)$$

(canonical ID problem with endogenous q)

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efficiency

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Results extend to “aggregate” welfare and “unconstrained” efficiency

inefficiency of the data economy

Private benefit for a type- ω consumer from selling her record is:

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If $U^*(\omega)$ and $\psi_{q^*}(\omega)$ sufficiently aligned eqm is constrained efficient (result)

Misalignment, and thus the eqm efficiency, depends on how platform uses the data, i.e., on its objective

$$\text{Recall: } v(a, \omega) = \gamma_u u(a, \omega) + \gamma_\pi \pi(a, \omega)$$

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Proposition

- ▶ If $\gamma_u < \gamma_\pi$, equilibria are constrained efficient and consumers' welfare is maximal
- ▶ If $\gamma_u \geq \gamma_\pi$, equilibria can be inefficient (and consumers' welfare can be minimal, i.e., $\sum_{\omega} r(\omega) \bar{q}(\omega)$)

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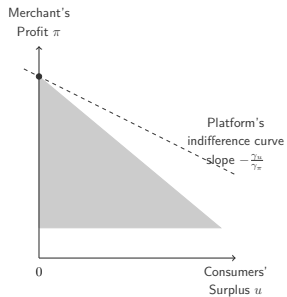
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Equilibrium efficient when platform cares more about merchant \rightsquigarrow **Why?**

If $\gamma_u < \gamma_\pi$

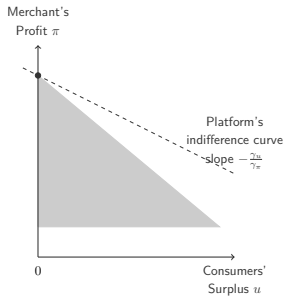


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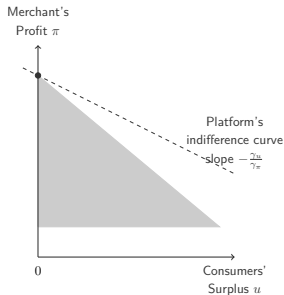


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- At all q , **full disclosure** is optimal
- Merchant extracts surplus from all consumers



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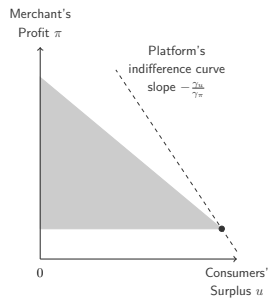


- At all q , **full disclosure** is optimal
- Merchant extracts surplus from all consumers
- Therefore, $\xi^*(\omega) = \sum_a x^*(a, \omega) u(a, \omega) = 0$
- Therefore, $\psi_q^* = U^*$, perfect alignment
- **Result:** All equilibria are constrained efficient

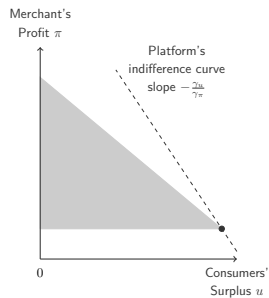
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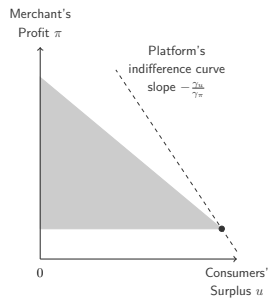
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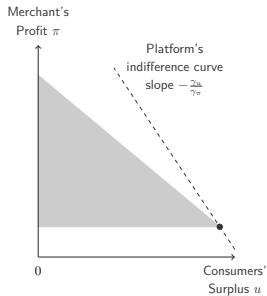


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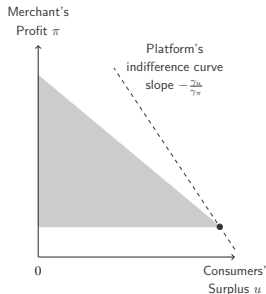


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- Platform **withholds information** from merchant



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- Platform **withholds information** from merchant
- Pooling different consumers together makes their payoff inter-dependent
- Thus, $\xi^*(\omega) \neq \sum_a x^*(a, \omega) u(a, \omega)$
- Example: think of lowest-type consumer
- Externalities \rightsquigarrow Eqm inefficiency

To avoid trivial cases, focus on economies where the constrained efficient allocation requires some trade, i.e., $W^o > \sum_{\omega} \bar{q}(\omega)r(\omega)$

Corollary

Let $\gamma_{\pi} \leq \gamma_u$ and, additionally, suppose $\gamma_u \underline{\omega} < r(\underline{\omega}) < (1 + \gamma_u)\underline{\omega}$.
Then, **all equilibria** are inefficient.

Ubiquitous role of information intermediaries in digital markets Acquisti et al. '16

A defining feature of these intermediaries is that they balance interests of conflicting agents (sellers-buyers; drivers-riders, etc.)

Typically, these conflicts are managed by optimally withholding some information from the agents

This paper illustrates how this practice can create market failures

Force is more general than our price-discrimination application with a monopolist merchant

example

Suppose:

- $\gamma_u > \gamma_\pi = 0$, i.e. platform only cares about consumers' surplus
- Only two types of consumers: $\Omega = \{1, 2\}$ with $\bar{q}(1) < \bar{q}(2)$
- Same reservation utility: $r(\omega) = \bar{r} \in (0, \frac{1+\gamma_u}{2})$, for all ω

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There is a **unique** constrained-efficient allocation (q°, x°) :

- All low-type consumers sell: $q^\circ(1) = \bar{q}(1)$
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A Simple Example to Illustrate

example

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We can show that $p^*(\omega) \leq \gamma_u$. This implies that:

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Why? $U^*(1) = p^*(1) \leq \gamma_u < \bar{r}$

Do not internalize positive externality that selling their record generate for high-type consumers

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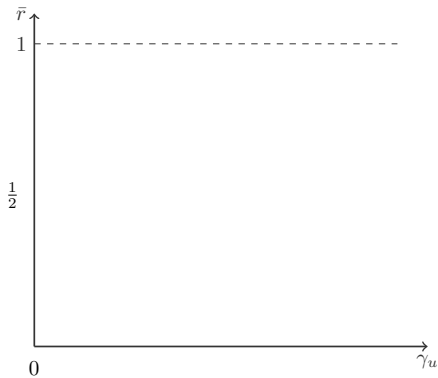
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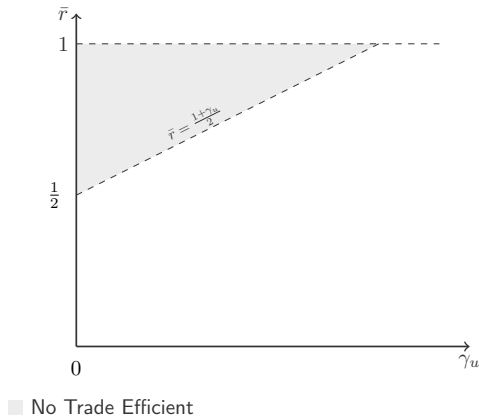
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- Market unravels \rightsquigarrow No trade \rightsquigarrow Inefficiency

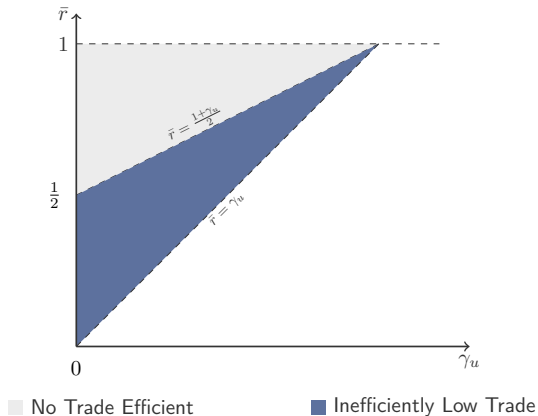
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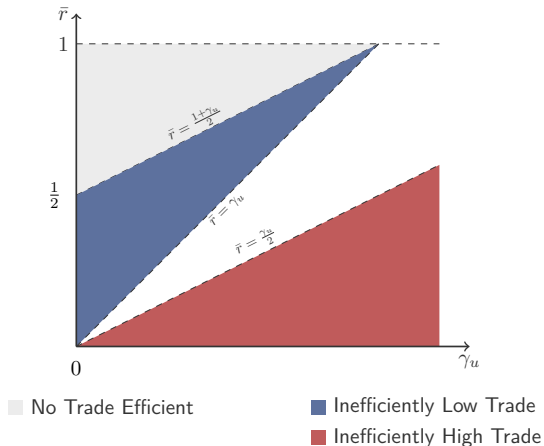
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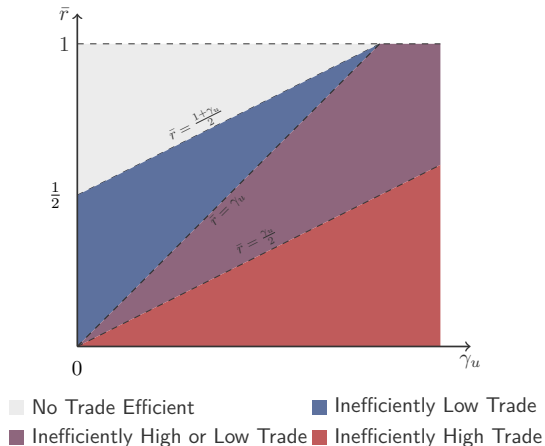
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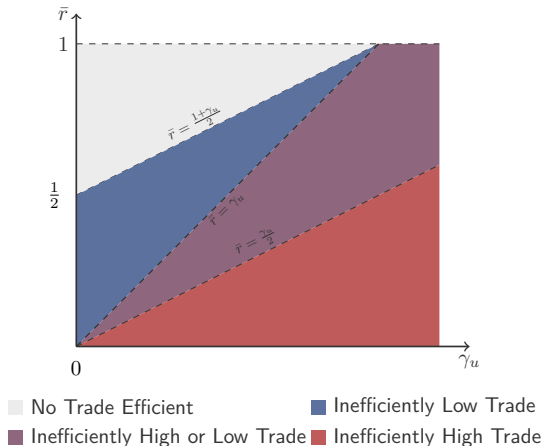
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remedies

How to fix this market failure?

We explore three alternative market designs:

1. Introducing a **data union**
2. Implementing **data taxes**
3. Making data markets more **complete**

data union

Recent policy proposals for the data economy (Posner, Weyl, 18; Seim et al 23)

A data union would represent consumers by managing data on their behalf

First model of a data union, we offer theoretical support to these policy proposals

How does a data union work?

- Consumers choose whether to become members of the union
- If they do, they relinquish their data to the union
- Union sells some of this data to the platform

Consumers retain reservation utility unless record is sold to platform

- With the proceeds of sale, union compensates all participating consumers (to incentivize their participation)
- Union maximizes welfare of participating consumers

Formally, the data union problem is:

$$\max_{(p,q,x)} \quad \sum_{\omega} p(\omega) \bar{q}(\omega) + \sum_{a,\omega} u(a,\omega) x(a|\omega) q(\omega) + \sum_{\omega} (\bar{q}(\omega) - q(\omega)) r(\omega)$$

such that $q \leq \bar{q}$,

and $\sum_{\omega} p(\omega) \bar{q}(\omega) = V(q)$,

and x solves \mathcal{P}_q ,

and $p(\omega) + \frac{q(\omega)}{\bar{q}(\omega)} \sum_a u(a,\omega) x(a|\omega) + \left(1 - \frac{q(\omega)}{\bar{q}(\omega)}\right) r(\omega) \geq r(\omega)$.

Proposition

Equilibria of the data-union economy are constrained efficient and maximize consumers' welfare (and vice versa), regardless of the platform's objective

Some intuition:

Data union coordinates consumers by deciding which records to sell and how to compensate them

By doing so, data union acts as a substitute for the competitive market and avoids market failure

data taxes

Enrich competitive economy by introducing a simple **data tax**:

- ▶ When selling her record, consumer pays tax $\tau(\omega) \in \mathbb{R}$ to the govt

When properly designed, data taxes force consumers to internalize effects that selling their records create on economy

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Proposition

Let (q°, x°) be a constrained-efficient allocation. There exists a profile of taxes τ^* , of prices p^* , and of consumer choices ζ^* , such that $(p^*, \zeta^*, q^\circ, x^\circ)$ is an equilibrium of the economy with taxation τ^* and the government does not run a deficit.

Let allocation (q°, x°) be constrained efficient

Let p^* be a supergradient of $V(q^\circ)$

Define $\tau^*(\omega) \triangleq p^*(\omega) + \sum_a x^\circ(a|\omega)u(a, \omega) - r(\omega)$

Notice that $U^*(\omega) - \tau^*(\omega) \equiv r(\omega)$

Therefore, all consumers indifferent \rightsquigarrow choose ζ^* to implement q°



more-complete markets

We let price of data depend not only on its type (i.e., ω) but also on its “intended use” (i.e., a)

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This is reminiscent of GDPR: “*The **specific purposes** for which personal data are used should be determined at the time of the collection*”

A market for each (a, ω) , where ω -records can be traded for use a at price $p(a, \omega)$

Our equilibrium definition extends naturally to this richer economy

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Proposition

Equilibria of this economy are (unconstrained) efficient and maximize consumers' welfare, regardless of platform's incentives

related work

Related Work

Model rooted in a GE tradition but leverages on progress in info-design literature, which offers microfoundation for key components of a data economy:

- E.g., how data is used (BBM '15); How data is valued (GLP '23); How data is priced (this paper)

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We contribute to a recent literature that studies data markets:

- “Learning” externality Choi et al ('19), BBG ('22), Acemoglu et al. ('22)
- Our inefficiency: Not due to exogenous correlation, but to platform's role as info intermediary building on GLP '23

Related Work

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More broadly, we contribute to the growing literature on the economics of platforms, data, & privacy Jones and Tonetti '20, Hidir and Vellodi '21, Chen '22

conclusion

1. A stylized framework to study competitive markets for personal data

Rooted in GE tradition but leveraging recent progress in info-design

2. Identify novel inefficiency leading this otherwise perfectly competitive market to fail

Show how inefficiency critically depends on platform's role as an information intermediary

3. Propose three alternative market designs that fix inefficiency: data unions, data taxes, richer data prices

Competitive Markets for Personal Data

Simone Galperti
UCSD

Tianhao Liu
Columbia

Jacopo Perego
Columbia

Thank You!

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Bonus: In eqm, platform makes not profits. Thus, $W(q^*, x^*)$ equals consumer welfare. Thus, any constrained-efficient eqm maximizes consumer welfare

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Substantive: price-taking behavior, i.e. competitiveness of the market

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Three aspects of the consumer problem have been simplified:

Record fully reveals underlying type alt see GLP '23

Record bundles access and information alt see ALV '22

Reservation utility $r(\omega)$ is exogenous alt see BB '23