

# The Ownership of Data

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# Motivation

- Advent of **internet** and **digital age**
- Companies collect, control and monetise valuable **personal data**
  - ▶ Targeted advertising (Facebook, Google, etc.)
  - ▶ Product improvements
  - ▶ etc.
- **Privacy concerns:**
  - ▶ Privacy intrusion
  - ▶ Price discrimination
  - ▶ etc.

# Regulations

- **General Data Protection Regulation (GDPR)**
  - ▶ right to informed consent
  - ▶ right to be forgotten
  - ▶ right to data portability
  - ▶ etc.
- **California Consumer Protection Act (CCPA)**
- Many open questions:
  - 1 personal vs. non-personal data?
  - 2 type of consent?
  - 3 lawfulness of data processing?

# Data Ownership?

## Current state of the law does not directly address the question of ownership

*...We are also united in our belief that consumers should have meaningful rights over their personal information and that companies that access this information should be held consistently accountable under a comprehensive federal consumer data privacy law”.*

Open letter (Sep 2019) by Bezos (Amazon), Rometty (IBM), Barry (Best Buy), etc.

- Why?

- ▶ Regulations limit but do not prevent firms from processing data
- ▶ Consumers' limited understanding blurs these limits
- ▶ **“Privacy paradox”**: users' strong privacy concerns are not reflected in online behaviour

# Objectives of the Paper

## Economic analysis of the ownership of data

- Model based on three observations:
  - ① data is **by-product of a primary activity**
  - ② data **generates monetary value**
  - ③ users (data subjects) suffer **privacy cost**
- Questions:
  - ① Should companies control the data generated from interaction with consumers?
  - ② Would consumers benefit if they owned the data?
  - ③ Is paying for privacy better than giving the data to consumers?

# Literature

- **Property rights:**

- ④ **Coase (1960):** property rights solve externalities but their allocation is irrelevant
- ② **Mechanism design:** property rights irrelevant under complete contracts (e.g., Dasgupta-Hammond-Maskin, 1979)
- ③ **Williamson (1975); Grossman-Hart (1986):** property rights and their allocation relevant under incomplete contracts

- **Most closely related:**

- ④ **Jones-Tonetti (2020):** non-rivalry aspect of data and gains under consumers' right (growth model)

- **Two-sided markets:**

- ④ Caillaud-Jullien (2003); Rochet-Tirole (2006); Armstrong (2006)

# Road Map

- 1 Model
- 2 Optimal mechanism under complete contracts
- 3 Incomplete contracts and property rights
- 4 Extensions
  - ▶ Paying for privacy
  - ▶ Consumer's right and sell "all or nothing"
- 5 Conclusions

# Model

- **Consumers** unif. distr. in  $[0, 1]$  (consumer's type  $\theta \in [0, 1]$  private info)
- **Firm** provides a service;  $q$  is **usage** (i.e., time spent online)
- Consumer's  $\theta$  (gross) utility:  $\theta q - q^2/2$



# Model

One piece of usage  $\rightarrow$  one piece of info (data)

- **Feasibility constraint:**  $e \leq q$
- **Privacy cost:**  $C(e) = \gamma e^2/2, \gamma > 0$
- **Data processing and value:**
  - ①  $\alpha > 0$  **per unit (gross) monetary value** available at **per unit cost**  $k$  paid by firm
  - ②  $\delta \in [0, 1]$  share of value available for free (i.e., at zero cost)
  - ③ Gross monetary value:  $B_v(\alpha, e)$ , where  $v \in \{\delta, 1\}$  and  $B_1(\alpha, e) = (\alpha - k)e$ ,  
 $B_\delta(\alpha, e) = \delta\alpha e$
- **Optimal (net) value of data:**

$$\phi_v(q) := \max_{e \leq q} B_v(\alpha, e) - C(e)$$

# Everything Contractible

## Data extraction and processing contractible

(allocation of property rights irrelevant)

- The firm processes any data iff

$$\alpha \geq \bar{\alpha} := \frac{k}{1 - \delta}$$

- **Direct Revelation Mechanism:**

$$(t(\cdot), q(\cdot), e(\cdot))$$

## Firm's Problem

$$\max_{(t(\cdot), q(\cdot), e(\cdot))} \int_0^{\bar{\theta}} \{t(\theta) + B_v(\alpha, e(\theta))\} d\theta$$

s.t.

$(t(\cdot), q(\cdot), e(\cdot))$  incentive compatible (IC)

$$q(\theta) \geq 0 \quad \forall \theta$$

$$0 \leq e(\theta) \leq q(\theta) \quad \forall \theta$$

# Incentive Compatibility

- Type  $\theta$ 's indirect utility:

$$U(\theta) = \theta q(\theta) - q^2(\theta)/2 - C(e(\theta), \alpha) - t(\theta) \quad (1)$$

- **Mechanism IC** only if:

- ①  $q(\cdot)$  non-decreasing
- ②  $\dot{U}(\theta) = q(\theta)$

- **Information rent:**

$$U(\theta) = U(0) + \int_0^\theta q(\tau) d\tau \quad (2)$$

- **Transfer** by combining (??) and (??):

$$t(\theta) = \theta q(\theta) - q^2(\theta)/2 - C(e(\theta), \alpha) - \int_0^\theta q(\tau) d\tau$$

## Transformed Firm's Problem

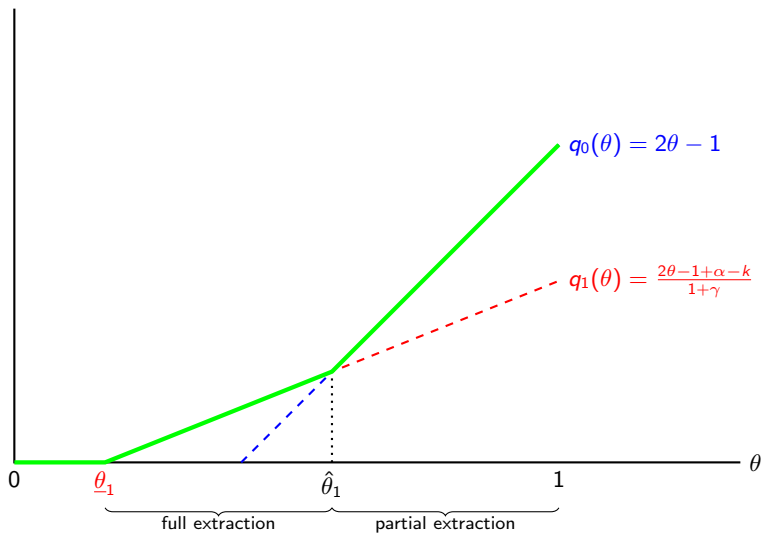
$$\max_{q(\cdot)} \int_0^{\bar{\theta}} \left\{ \theta q(\theta) - q^2(\theta)/2 + \phi_v(q(\theta)) - \underbrace{\int_0^\theta q(\tau) d\tau}_{\text{information rent}} \right\} d\theta$$

s.t.

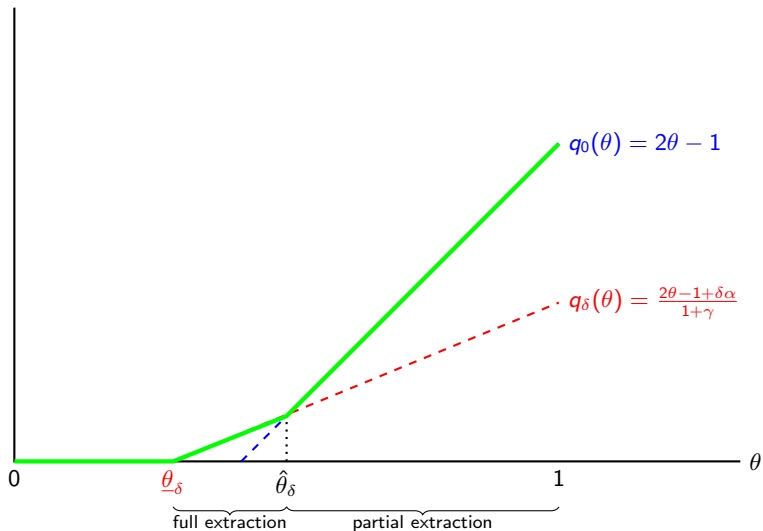
$q(\cdot)$  non-decreasing

$$q(\theta) \geq 0 \quad \forall \theta$$

## Optimal Mechanism ( $\alpha \geq \bar{\alpha}$ )



## Optimal Mechanism ( $\alpha < \bar{\alpha}$ )



## Remarks on Optimal Mechanism

- 1  $q_v(\cdot)$  increasing in  $\alpha$  for every  $\theta$  and  $v \in \{0, 1\}$
- 2  $\underline{\theta}_v$  decreasing in  $\alpha$  for every  $v \in \{0, 1\}$  (**two-sided market**)
- 3  $\alpha$  sufficiently high  $\Rightarrow$  all consumers purchase  $\Rightarrow t(\cdot)$  negative (firm subsidises)



# Non-Contractible Data Extraction and Property Rights

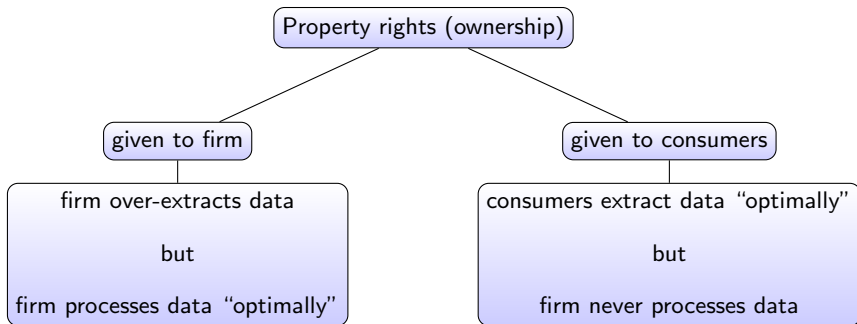
**Data extraction and processing non-contractible**

(but usage contractible)

**Property right (ownership): (residual) right to control data extraction**

(as in Grossman and Hart, 1986)

# Ownership Regime

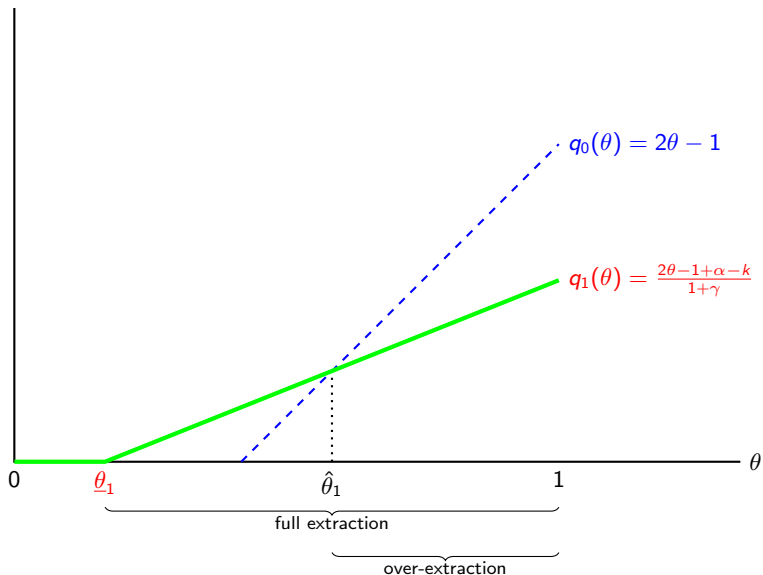


**Trade-off: over-extraction vs. under-processing**

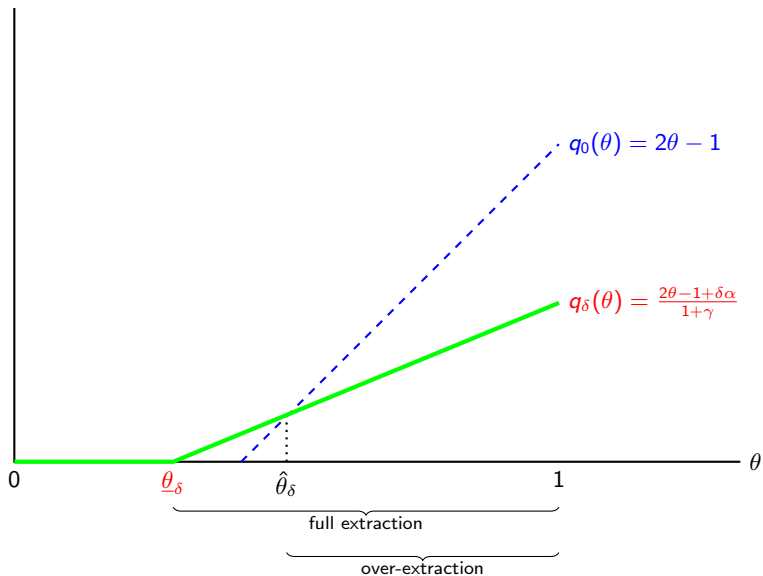
# Firm's Right

- Status quo in most countries regardless of regulation (e.g., GDPR, CCPA)
- Remarks:
  - ▶ Firm extracts all data from all consumers who purchase (**no commitment**)
  - ▶ Consumers anticipate full extraction and refrain from consuming a lot
  - ▶ Firm processes data iff  $\alpha \geq \bar{\alpha}$

# Optimal Mechanism ( $\alpha \geq \bar{\alpha}$ )



## Optimal Mechanism ( $\alpha < \bar{\alpha}$ )



## Payoffs and Inefficiencies

- Firm's profit:

$$\Pi^F = \int_{\underline{\theta}_v}^1 \left[ (2\theta - 1)q_v(\theta) - q_v^2(\theta)/2 + B_v(\alpha, q_v(\theta)) - C(q_v(\theta)) \right] d\theta$$

- Consumer surplus:

$$CS^F = \int_{\underline{\theta}_v}^1 q_v(\theta)(1 - \theta)d\theta$$

**Excessive data extraction for  $\alpha$  not sufficiently high**

# Consumer's Right

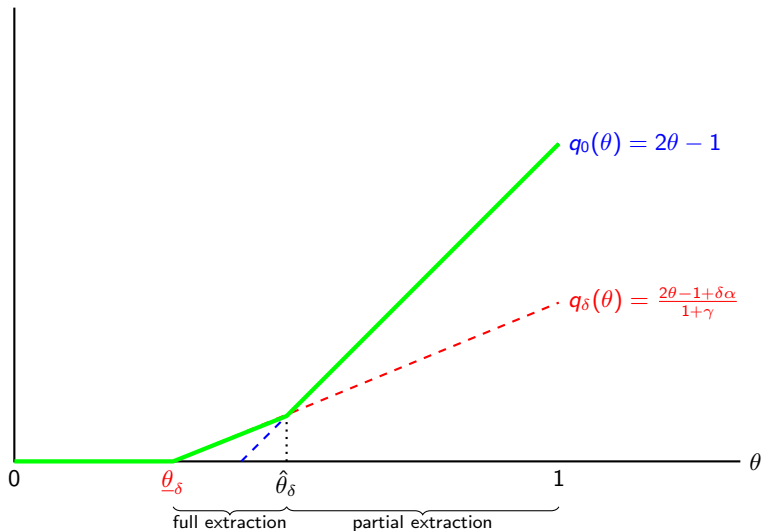
- Until recently unrealistic
- Two recent developments:
  - ① Regulations (e.g., GDPR): **data portability** allows consumers to transfer “raw” data from one firm to another
  - ② Platforms: [www.people.io](http://www.people.io), [datacoup.com](http://datacoup.com), [wibson.org](http://wibson.org) offer tools that help users obtain part of the monetary returns of their data

- See for instance:

*“As of Today, European Consumers Can Profit From Selling Their Own Personal Data”, Forbes, 11 October 2018*

- Remarks:
  - ▶ Consumers can fine-tune data extraction
  - ▶ Firm never processes data

## Optimal Mechanism (any $\alpha$ )





## Payoffs and Inefficiencies

- Firm's profit:

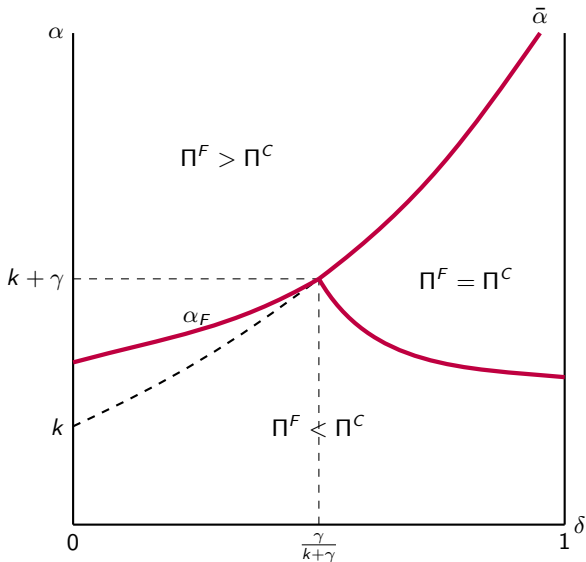
$$\begin{aligned}\Pi^C = & \int_{\underline{\theta}_\delta}^{\hat{\theta}_\delta} \left[ (2\theta - 1)q_\delta(\theta) - q_\delta^2(\theta)/2 + B_\delta(\alpha, q_\delta(\theta)) - C(q_\delta(\theta)) \right] d\theta \\ & + \int_{\hat{\theta}_\delta}^1 \left[ (2\theta - 1)q_0(\theta) - q_0^2(\theta)/2 + \phi_\delta(\bar{e}_\delta) \right] d\theta\end{aligned}$$

- Consumer surplus:

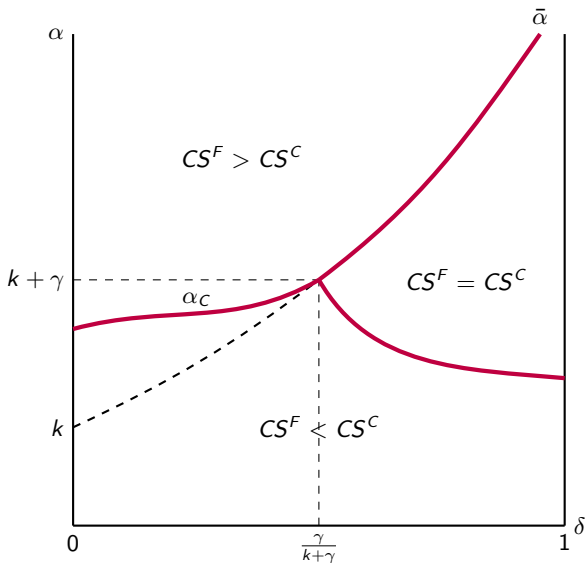
$$CS^C = \int_{\underline{\theta}_\delta}^{\hat{\theta}_\delta} q_\delta(\theta)(1 - \theta)d\theta + \int_{\hat{\theta}_\delta}^1 q_0(\theta)(1 - \theta)d\theta$$

**Low types' usage is inefficient iff  $\alpha > \bar{\alpha}$**

## Main Result (Profit Comparison)



## Main Result (CS Comparison)



# Paying for Privacy

- Suppose firm owns rights and offers two goods:
  - ① a good that leaves the firm with all rights to any data
  - ② a good that guarantees that no data is extracted
- Consumers can **pay for privacy**
- Example: *basic version vs premium version*
  - ▶ YouTube
  - ▶ Game apps
  - ▶ etc
- Formally, firm offers DRM  $(t(\cdot), q(\cdot), e(\cdot))$  but
  - ①  $e(\theta) = 0$  no data extraction (i.e., privacy)
  - ②  $e(\theta) = q(\theta)$  full data extraction (i.e., no privacy)

## Firm's Problem with PFP

$$\max_{(q(\cdot), e(\cdot))} \int_0^{\bar{\theta}} \left\{ \theta q(\theta) - q^2(\theta)/2 + B_v(\alpha, e(\theta)) - C(e(\theta)) - \underbrace{\int_0^{\theta} q(\tau) d\tau}_{\text{information rent}} \right\} d\theta$$

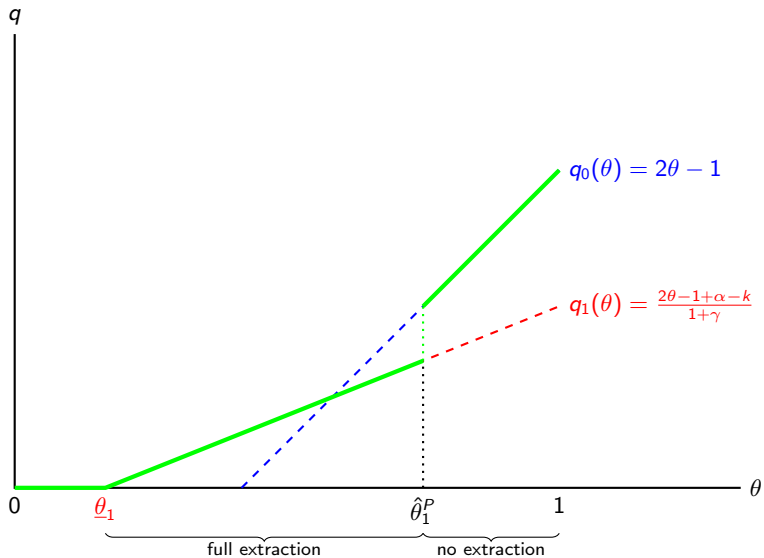
s.t.

$q(\cdot)$  non-decreasing

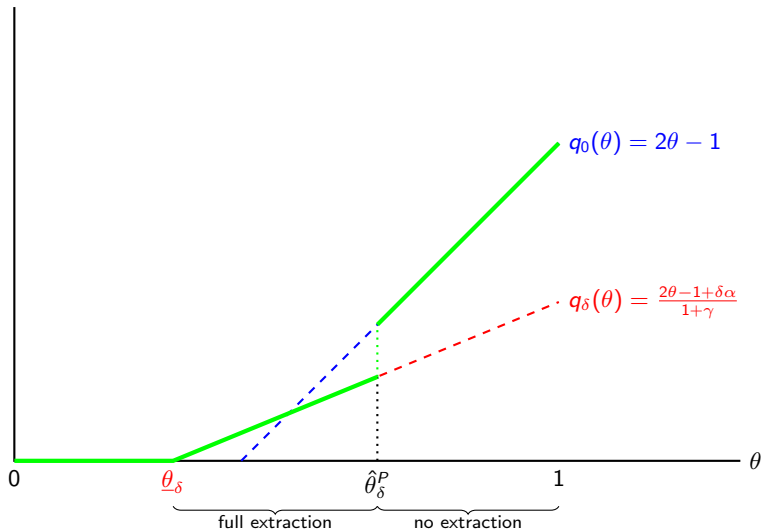
$$q(\theta) \geq 0 \quad \forall \theta$$

$$e(\theta) \in \{0, q(\theta)\} \quad \forall \theta$$

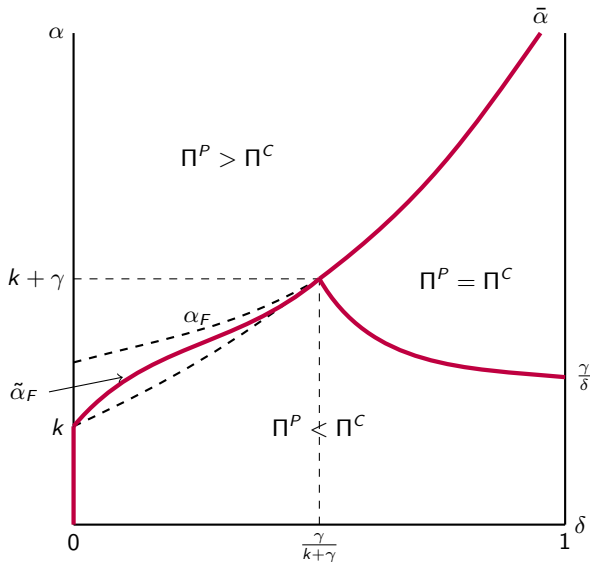
## Optimal PFP Mechanism ( $\alpha \geq \bar{\alpha}$ )



# Optimal PFP Mechanism ( $\alpha < \bar{\alpha}$ )

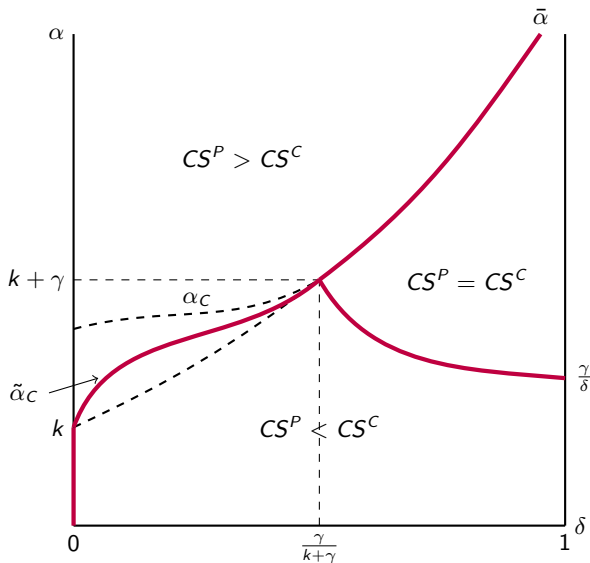


## Profit Comparison with PFP





## CS Comparison with PFP



# Conclusion

- **Motivation:** Property rights over personal data? Allocation?
- **Contribution:** Economic model to study trade-off between allocation of rights
- **Results:**
  - ① Optimal allocation depends on relative value of primary and secondary market
  - ② Paying for privacy benefits firms but not necessarily consumers (relative to the regime in which they own the rights)