The Distributional Effects of "Fulfilled By Amazon" (FBA)

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Introduction

Fulfillment by Amazon

- Fulfillment by Amazon (FBA): a fulfillment service that Amazon offers to merchants for a per-unit fee
- In 2020, nearly 50% of merchants on Amazon uses FBA
- Merchants have a 20–25% increase in sales after using FBA
- **Question:** what are the *welfare* implications of FBA upon consumers, merchants, and Amazon?
- **Answer:** 2 outcomes:

1. Consumers, merchants with low fulfillment service quality and Amazon gain, but merchants with high fulfillment service quality lose
2. Amazon extracts all gains of FBA, others stay the same

Model

- Static setting: time $t \in \{0,1,2\}$
- Three types of agents: consumers, two merchants, and a platform
- $t=0$: platform sets platform fee based on revenue and FBA fee per quantity
- $t=1$: each merchant decides if to use platform/ FBA and sets price (cannot use FBA off the platform)
- $t=2$: consumers buy from one merchant or an outside option with utility 0
- Each participant is rational: maximizes her own utility

Merchants' setup

Two merchants $j \in \{H, L\}$ defined by

- $\theta_j > 0$: product quality
- $\sigma_j \geq 0$: fulfillment service quality, $\sigma_H > \sigma_L$, normalize $\sigma_L = 0$

At $t=1$ merchant $j \in \{H, L\}$ simultaneously makes 3 decisions:

1. $\rho_j \in \{0,1\}$: join platform with fee f or not
2. $\eta_j \in \{0,1\}$: use FBA with fee T or not, using FBA changes σ_j to $\sigma_P \equiv \sigma_H$
3. $P_j \geq 0$: price set for the product
4. Use $d_j := (\rho_j, \eta_j, P_j)$ to represent actions of Merchant j

Model details

Merchants' problem

Merchant j solve (assume d_{-j} fixed)

$$d_j^\star(f,T) = (\rho_j^\star(f,T), \eta_j^\star(f,T), P_j^\star(f,T)) \in \underset{\rho_j\in\{0,1\},\eta_j\in\{0,1\},P_j\geq 0}{\arg\max} \Pi_j(\rho_j,\eta_j,P_j,d_{-j})$$

$\Pi_j(\rho_j,\eta_j,P_j,d_{-j})$: profit of Merchant j

$Q_j(\rho_j,\eta_j,P_j,d_{-j})$: demand of Merchant j

f : platform fee

T : FBA fee

$$\Pi_j(\rho_j,\eta_j,P_j,d_{-j}) = \begin{cases} P_j \cdot Q_j & \text{if } \rho_j = 0 \\ P_j \cdot Q_j - f \cdot P_j \cdot Q_j & \text{if } \rho_j = 1, \eta_j = 0 \\ P_j \cdot Q_j - f \cdot P_j \cdot Q_j - T \cdot Q_j & \text{if } \rho_j = 1, \eta_j = 1 \end{cases}$$

Platform's problem

Platform anticipates $P_j^\star(f,T), Q_j^\star(f,T)$ given fees (f,T), and sets fees optimally to solve:

$$(f^\star, T^\star) \in \underset{f\in[0,1],T\geq 0}{\arg\max}\ \Pi_P(f,T;d)$$

$$\Pi_P(f,T;d) = f\left(\sum_{j\in M_P^\star(f,T)} \underbrace{P_j^\star(f,T)\cdot Q_j^\star(d(f,T))}_{\text{revenue of } j}\right) + T\left(\sum_{j\in M_F^\star(f,T)} \underbrace{Q_j^\star(d(f,T))}_{\text{demand of } j}\right)$$

$M_P^\star(f,T)$ = set of merchants using platform

$M_F^\star(f,T)$ = set of merchants using FBA $\subseteq M_P^\star(f,T)$

Consumers' problem

- A measure of consumers indexed by $i \in [0, 1+\Delta]$
- Utility $U_i(j,d_j)$ of consumer i from buying Product j as a function of Merchant j's decisions, $d_j = (\rho_j, \eta_j, P_j)$:

$$U_i(j,d_j) = \underbrace{X_{i,j}}_{\text{Consumption Value}} - \underbrace{P_j}_{\text{Product Price}} + \underbrace{s_j(\rho_j,\eta_j)}_{\text{Fulfillment Service Value}}$$

- $X_{i,j} \sim \exp(\theta_j^{-1})$, independent across i, j, $\mathbb{E}(X_{i,j}) = \theta_j$

$$s_j(\rho_j,\eta_j) = \begin{cases} \sigma_P & \text{if } \rho_j \cdot \eta_j = 1 \\ \sigma_j & \text{otherwise} \end{cases}$$

- Outside option with utility 0

Demand function and main results

- Consumer $i \in [0,1]$ sees product sold by all merchants
- Consumer $i \in (1, 1+\Delta]$ sees Product j only if Merchant j sells on the platform, i.e., $\rho_j = 1$

Demand of Merchant j when both merchants make decisions $d = (d_L, d_H)$

$$Q_{j,[0,1]}(d_j,d_{-j}) = \underbrace{\left(1 - \frac{\theta_j^{-1}}{\theta_j^{-1}+\theta_{-j}^{-1}} \cdot \pi_{-j}(d_{-j})\right)}_{\text{does not depend on } d_j} \cdot \pi_j(d_j)$$

where $\pi_j(d_j) = e^{-\theta_j^{-1}\left(P_j - s_j(\rho_j,\eta_j)\right)^+} = \mathbb{P}\left(U_i(j,d_j) > 0\right)$

$$Q_{j,\Delta}(d_j,d_{-j}) = \rho_j\Delta \underbrace{\left(1 - \frac{\theta_j^{-1}}{\theta_j^{-1}+\theta_{-j}^{-1}}\, \rho_{-j}\pi_{-j}(d_{-j})\right)}_{\text{does not depend on } d_j} \cdot \pi_j(d_j)$$

- Compare 2 equilibria: with/ without FBA
- Merchant L: weakly better, $\sigma_L \uparrow \sigma_P$, $T^\star$ not too large
- Merchant H: weakly worse, even though $P^\star_{H,\text{FBA}} = P^\star_H$
- Consumers: weakly better, $P^\star_{L,\text{FBA}} - P^\star_L \leq \sigma_P - \sigma_L$
- Platform: strictly better:
  - No FBA (force $\eta_j = 0$): both use platform, $P^\star_H = \theta_H, P^\star_L = \theta_L$
  - With FBA: both use platform, only L uses FBA, $P^\star_{H,\text{FBA}} = \theta_H, P^\star_{L,\text{FBA}}$ $\theta_L + \frac{T^\star}{1-f^\star}$

1. When effects on merchants and consumers are zero: platform takes all values generated through FBA
2. Otherwise: only H loses, everyone else gains

When will H lose, L, consumers, and platform gain?

- θ_L is small
- $T^\star$ is "interior": L strictly prefers to use FBA

1. θ_L small: Q_L sensitive to $T \uparrow$, difficult to extract values from FBA
2. θ_L larger: Q_L less sensitive to $T \uparrow$, easier to extract values from FBA