Towards Economic Models for MOOC Pricing Strategy Design

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- Challenges for MOOCs: low completion rate, operational sustainability, etc.
- Proportion of paying users increases for online education
  - % of paying users for online education:
    26% (Year 2015) ⇒ 70% (Year 2016)
  - % of paying users for MOOCs: 11% (Year 2016)
    (Source: Survey from jiemodui in Jan, 2017)
- Little academic research on analyzing the business models

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- Build theoretical models for the pricing strategies
- Analyze sales data from 1236 real MOOCs
- Get business/education insights from models and data

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- B2C (Business-to-Customer)
- B2B (Business-to-Business)
- C2C (Customer-to-Customer, e.g Udemy/Skillshare)

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Basic Strategy: *Freemium*

Open and free basic courses + fee-based online value-added services

Objectives for B2C pricing strategies:

- Model 1 - Maximize per-MOOC profit
- Model 2 - Maximize per-user profit across multiple MOOCs

- Basic assumptions for each MOOC $\mathcal{M}$:
  - Exclusive license to the platform
  - One seller (MOOC platform), multiple buyers
  - Flat-rate price p

The assumptions holds for most of the MOOCs around the world.

Overview of Model 1

For MOOC $\mathcal{M}$ with enrollments J, given users' utility of taking the course without paying and users' utility (i.e. WTP) of the certificate under price p, get the profit maximization pricing strategy for $\mathcal{M}$.

Key Notations

- V_j - Utility to user j of taking the course and buying a non-free certificate (i.e. WTP)
- $\bar{V}_j$ - Utility to user j of taking the course or without paying
- $U_j(x_j, p)$ - Consumer surplus for user j with decision $x_j \in \{0, 1\}$ under price p. ($\forall j \in \{1, 2, \cdots, J\}$)

$$U_j(0, p) = \bar{V}_j, \quad U_j(1, p) = V_j - p, \quad \forall j \in \{1, 2, \cdots, J\} \tag{1}$$

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Definition (Demand functions)

The decision of user j under price p (i.e. demand function) is:

$$x_j^*(p) = \begin{cases} 1 & \text{if } U_j(1,p) > U_j(0,p) \\ 0 & \texttt{otherwise} \end{cases} \quad \forall j \in \{1, 2, \cdots, J\} \tag{2}$$

Add up all the demand functions of $x_j^*(p)$ for $j \in \{1, 2, \cdots, J\}$, the aggregate demand function (i.e the total demand of MOOC $\mathcal{M}$) is $D(p) = \sum_{j=1}^{J} x_j^*(p)$

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Cost Structure

MOOC services have high fixed cost but low marginal cost (denoted as $\bar{c}$ for MOOC $\mathcal{M}$).

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Theorem (Pricing Strategy for Profit Maximization)

The profit maximization pricing strategy for MOOC $\mathcal{M}$ is:

$$\bar{p} = argmax_p[D(p) \cdot (p - \bar{c})] \tag{3}$$

$\bar{p}$ is the platform's best pricing strategy for MOOC $\mathcal{M}$.

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In the real market, the MOOC platform should:

- Reduce the marginal cost
- Increase the variance between the non-free and free services
  - Improve the quality of value-added services
  - Reduce the utility gained from taking the course for free (Caution: may also reduce enrollments)

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Overview of Model 2

Each user takes multiple courses, given her utility of taking the course without paying or buying the certificate under price p, get the best strategy for the user and the platform.

Key Notations

- B_j - Fixed budget constraint for user j
- K_j - Maximum number of MOOCs that user j can take due to time limitation
- p_m - The price for course m's certificate
- $x_{j,m}(p_m)$ - User j's decision function of whether she j will pay for the certificate of course m under price p_m

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$$\text{maximize} \sum_{m \in [M]} x_{j,m}(p_m) \cdot (V_{j,m} - p_m) \tag{4}$$

s.t.

$$x_{j,m}(p_m) \cdot (V_{j,m} - \bar{V}_{j,m} - p_m) \geq 0, \quad \forall j \in [J]; \tag{5a}$$

$$\sum_{m \in [M]} x_{j,m}(p_m) \cdot p_m \leq B_j, \quad \forall j \in [J]; \tag{5b}$$

$$\sum_{m \in [M]} x_{j,m}(p_m) \leq K_j, \quad \forall j \in [J]; \tag{5c}$$

$$x_{j,m}(p_m) \in \{0, 1\}, \quad \forall m \in [M], j \in [J]. \tag{5d}$$

Objective function (4) - maximize user's total benefit

(5a) individual rationality, (5b) budget constraint, (5c) time constraint

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- Solving (4) is NP-hard
- Simplified when p_m is the same for each course $m \in [M]$

Theorem (Users' Demand Functions)

If p_m is same for each course (i.e. $p_m = p, \forall m \in [M]$), the demand function of user j is a function of p, $\{V_{j,m}\}_{m\in[M]}$, $\bar{V}_{j,m}$, K_j and B_j, such that:

$$D_j(p) = \sum_{m\in[M]} x_{j,m}(p_m) = \mathcal{F}_j\Big(p, B_j, K_j, \{V_{j,m}\}_{m\in[M]}, \{\bar{V}_{j,m}\}_{m\in[M]}\Big) \tag{6}$$

and the aggregate demand function is $D(p) = \sum_{j\in[J]} D_j(p)$

In the real market, the MOOC platform should:

- Schedule the popular MOOCs properly to reduce conflict
- Bundle courses together to make attractive portfolios
- Incorporate pricing strategy for membership fee

Bundled Courses

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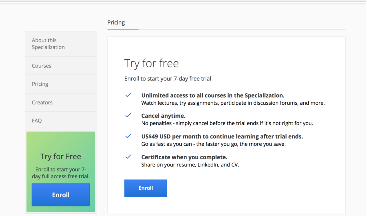

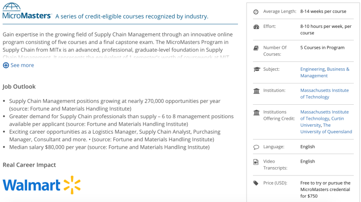

Pricing for bundled courses: Flat-rate + Membership Fee

- Specializations on Coursera (or the XSeries on edX)
- Online Micro Masters on edX (or Udacity)
- Advanced Placement (i.e. AP) courses

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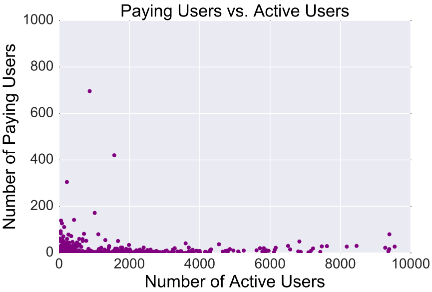
Sales data from 1236 real MOOCs (1140 MOOCs closed)

Three types of certificates:

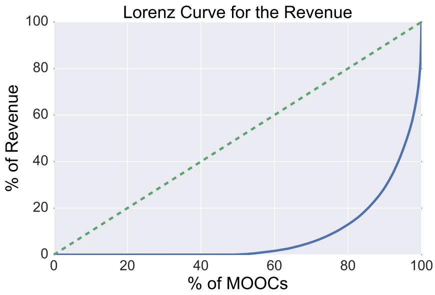
- Electronic Honor Code Certificate (Free)
- Paper Certificates (100RMB)
- Verified Certificate (300RMB)

From Definition (1) and (2) in Model 1

If a user completes the course, then WTP> 0
If a user buys a verified/paper certificate, then WTP ≥ 100
If a user buys a verified certificate, then WTP ≥ 300



- No direct relationship between the number of active users and paying users.
- Many factors as difficulties, popularities, and practicability may affect the relationship.



- Gini coefficient $= 0.838$
- Top 15% profitable MOOCs create $\geq 80\%$ of total revenue.

Analyze Real-world Sales Data
Best-selling MOOCs

Subject Category	Completion Rate	WTP>0	WTP≥ 100	WTP≥ 300
Accounting	2.9%	870	696	381
Marketing	1.3%	362	142	69
Startup	1.2%	385	111	63
Accounting	1.6%	110	72	48

- More users prefer the verified certificate (300RMB) to the paper certificate for each course.
- The paying users care more about the quality of service when the course is popular and useful.

Analyze Real-world Sales Data

Offer the Same MOOC Repeatedly

Semester	Completion Rate	WTP> 0	WTP≥ 100	WTP≥ 300
Fall 2015	2.9%	870	696	381
Spring 2016	1.3%	566	420	236
Summer 2016	1.8%	257	172	99

- Proportional relations of the three values for each semester are almost the same.
- Total number of paying users declines: the law of diminishing returns.

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Analyze Real-world Sales Data

MOOCs with the Highest Payment Rate

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Subject Category	Completion Rate	WTP>0	WTP≥ 100	WTP≥ 300
FE	0.24%	21	19	16
CS	0.45%	42	38	26
Maths	0.82%	9	8	5
CS	0.35%	29	25	17

- They are those science and engineering courses with high estimated efforts to complete.
- The paying users for these courses have higher WTPs as they have already invested much time in the courses.

Future Work

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- Other Factors Affecting the B2C Markets:

  1. Growing User Bases
  2. Competitions among MOOC Platforms
  3. Externalities
  4. Seasonality
  5. Promotion and Discount

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Conclusion Remarks

- Operational sustainability is critical for MOOC ecosystem
- Use economic models and data science methodologies to analyze the MOOC market
- Focus on both education and business insights

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Thank You

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Social welfare is the sum of the producer surplus and consumer surplus in the market. We use $\mathcal{SW}(p)$ to denote the social welfare at price p, and:

$$\mathcal{SW}(p) = \sum_{j \in [J]} U_j(1, p) + \sum_{j \in [J]} x_j^*(p) \cdot (p - \bar{c}) \tag{7}$$

- $\mathcal{SW}(p)$ will get its maximum at the *market equilibrium price* when $p = \bar{c}$ in a perfectly competitive market.
- When the MOOC market is highly competitive, the net profit of the platform may diminish.

Model 1: Maximize per-MOOC profit
A Game-Theoretic View

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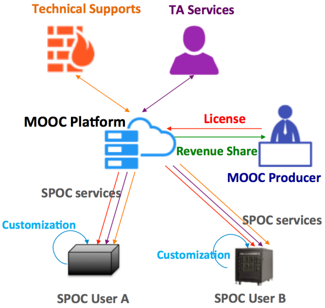
- The user-platform interaction is an example of a *Stackelberg game* with a leader-followers pattern.
- Stackelberg games often arise in user-platform interactions of the network economy, and we can use *backwards induction* to analyze.
- In practice, we can use the *backwards induction* to develop experiments to estimate the WTP of the users: The platform can dynamically change the price for certificates (e.g. make a discount) to figure out the WTP distribution at each price level.



- B2B services are dynamic and highly customized
- B2B2C model - Cross-platform MOOC exchange and internationalization