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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) \Rightarrow 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)

B2C Business Models

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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

B2C Business Models

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- 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.

Model 1: Maximize per-MOOC profit

Overview and Notations

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 . ($\forall j \in \{1, 2, \dots, J\}$)

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

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Model 1: Maximize per-MOOC profit

Demand Functions

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Definition (Demand functions)

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

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

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

Model 1: Maximize per-MOOC profit

Cost Structure

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Cost Structure

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

Model 1: Maximize per-MOOC profit

Profit Maximization

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Theorem (Pricing Strategy for Profit Maximization)

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

$$\bar{p} = \operatorname{argmax}_p [D(p) \cdot (p - \bar{c})] \quad (3)$$

\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)

Model 2: Maximize per-user profit

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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

Model 2: Maximize per-user profit

Problem Formulation

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

s.t.

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

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

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

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

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

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

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Model 2: Maximize per-user profit

Solving Ideas

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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:

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

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

Model 2: Maximize per-user profit

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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

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Job Outlook

- Supply Chain Management positions growing at nearly 270,000 opportunities per year (source: Fortune and Materials Handling Institute)
- Greater demand for Supply Chain professionals than supply - 6 to 8 management positions available per applicant (source: Fortune and Materials Handling Institute)
- Exciting career opportunities as a Logistics Manager, Supply Chain Analyst, Purchasing Manager, Consultant and more. (source: Fortune and Materials Handling Institute)
- Median salary \$80,000 per year (source: Fortune and Materials Handling Institute)

Real Career Impact



Average Length:	6-14 weeks per course
Effort:	8-10 hours per week, per course
Number of Courses:	5 Courses in Program
Subject:	Engineering, Business & Management
Institution:	Massachusetts Institute of Technology
Institution Offering Course:	MicroMasters Institute of Technology, Center University, The University of Queensland
Language:	English
Video Transcripts:	English
Price (USD):	Free to try or purchase the MicroMasters credential for \$750

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

Analyze Real-world Sales Data

Dataset Description

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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

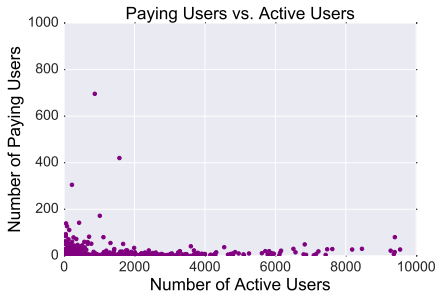
If a user completes the course, then $WTP > 0$

If a user buys a verified/paper certificate, then $WTP \geq 100$

If a user buys a verified certificate, then $WTP \geq 300$

Analyze Real-world Sales Data

Overview: Active Users vs. Paying Users



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

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Analyze Real-world Sales Data

Overview: Revenue Generating

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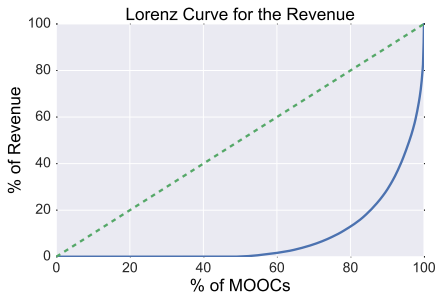
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- Gini coefficient = 0.838
- Top 15% profitable MOOCs create $\geq 80\%$ of total revenue.

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Best-selling MOOCs

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Subject Category	Completion Rate	WTP > 0	WTP \geq 100	WTP \geq 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

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Semester	Completion Rate	WTP > 0	WTP \geq 100	WTP \geq 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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MOOCs with the Highest Payment Rate

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Subject Category	Completion Rate	WTP > 0	WTP \geq 100	WTP \geq 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.

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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

Thank You

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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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Model 1: Maximize total profits for each MOOC

Social Welfare

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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:

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

- $\mathcal{SW}(p)$ 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.

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Modeling the B2B Market

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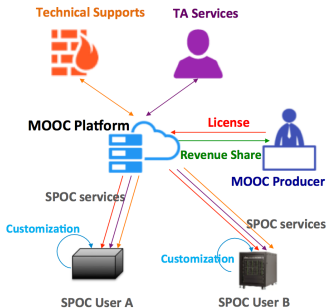
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- B2B services are **dynamic** and **highly customized**
- B2B2C model - Cross-platform MOOC exchange and internationalization