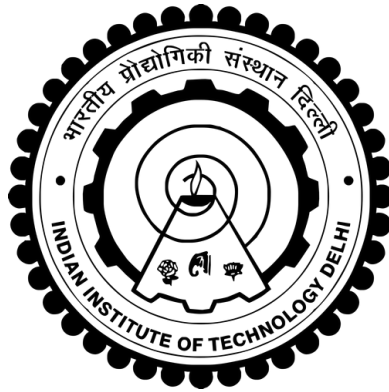


**ESSAYS ON PRICING AND COMPETITIVE
STRATEGIES OF TWO-SIDED PLATFORMS**

NEAKETA CHAWLA



DEPARTMENT OF HUMANITIES AND SOCIAL SCIENCES

INDIAN INSTITUTE OF TECHNOLOGY DELHI

March 2022

©Indian Institute of Technology Delhi (IITD), New Delhi, 2022

**ESSAYS ON PRICING AND COMPETITIVE
STRATEGIES OF TWO-SIDED PLATFORMS**

by

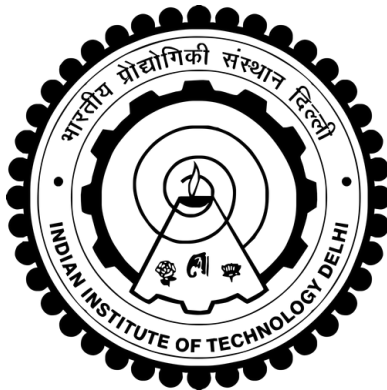
NEAKETA CHAWLA

Department of Humanities and Social Sciences

submitted

in fulfilment of the requirements for the degree of Doctor of Philosophy

to the



INDIAN INSTITUTE OF TECHNOLOGY DELHI.

March 2022

CERTIFICATE

This is to certify that the thesis titled “Essays in Pricing and Competitive Strategies of Two-Sided Platforms”, submitted by Neaketa Chawla to the Indian Institute of Technology, Delhi, for the award of degree of Doctor of Philosophy, is a bona fide record of research work done by her under our supervision. The content of this thesis, in full or in parts, has not been submitted to any other Institute or University, for the award of any degree or diploma.

Dr Debasis Mondal

Associate Professor

Department of Humanities and Social Sciences

Indian Institute of Technology, Delhi

Dr Sourabh B. Paul

Assistant Professor

Department of Humanities and Social Sciences

Indian Institute of Technology, Delhi

ACKNOWLEDGEMENTS

I consider myself extremely lucky to have very supportive mentors. Dr Debasis Mondal has been extraordinarily kind and patient throughout my research journey. He has endured long meetings with me, where we have painstakingly worked out detailed proofs of many papers. Never did he show any sign of displeasure or discomfort, even when I got stuck or was unable to proceed for some reason. He always gave me the time and space to work out things independently, making me the researcher I am today. I will always be grateful for his constant support.

Dr Sourabh B. Paul has always provided words of encouragement whenever I needed them the most. He constantly inculcated a sense of community amongst his students and went out of his way to make us feel at home in IIT Delhi. Dr Jayan Jose Thomas, Dr Reetika Khera and Dr Ankush Aggrawal have always provided valuable feedback on my work. Interaction with other faculty members of the department and the institute has also deeply enriched my research work.

I sincerely acknowledge the support of the administrative staff of the HSS department at IIT Delhi. They have always ensured timely completion of all my applications and requests. I also want to thank my friends and colleagues in the department who have made this journey very enjoyable. A special mention to my friend Mihir, who helped me understand mathematics differently. My family has always been a constant support, and I am grateful for their love and affection.

Finally, I would never have been able to complete my research, let alone write a thesis, had it not been for my friend Prakriti. She has been a pillar of strength, a guiding force and a true confidant. She has always pushed me to do better both professionally and otherwise. She picked me up when I was at my lowest and gave me the strength to carry on. I thank her from the bottom of my heart for always being there.

Neaketa Chawla

ABSTRACT

Two-sided platforms facilitate interactions between two types of agents. Four of the top five technology companies of today are two-sided platforms that connect two or more distinct groups of users. Facebook, Amazon, Apple, and Google provide the digital infrastructure to bring together different user groups. My dissertation consists of the following three essays which contribute to the literature of two-sided platforms.

Essay I: Seller Competition on Two-sided Platforms: We study how negative direct effects amongst sellers affect a platform's pricing decisions and the number of buyers and sellers on it. We use a CES utility function to model competition amongst sellers on the platform. However, we modify the function to disentangle the interdependence between product variety and product substitutability. We find that an increase in the intensity of competition is not necessarily detrimental for a seller on a two-sided platform. In fact, increase in product substitutability that increases price competition leads even more sellers to join the platform by putting a downward pressure on the price and attracting more consumers. Increase in competition also leads to increased profits for the platform when it implements subscription pricing. On the other hand, the sellers' participation and platform's profit can be increasing or decreasing when the platform implements usage pricing.

Essay II: Fulfilled by Amazon- An Economic Analysis of E-commerce Platforms that provide Delivery Service: Digital platforms have been the subject of antitrust scrutiny because of their participation in multiple lines of business. We model a two stage game where the platform determines the optimal price for its delivery service in the first stage when there are two types of sellers- sellers that use the platform's delivery service and sellers who undertake their own delivery. Sellers decide how much quantity to produce in the second stage. The competition amongst sellers is modelled using a Cournot quantity game. The model investigates

how seller heterogeneity impacts optimal delivery price and subsequently the optimal profit of the platform. We find that the platform's profit is negatively related to the cost of the sellers that buy its delivery service and positively related to the cost of sellers that perform their own delivery. We further extend this analysis to a case where the platform also competes with the third-party sellers to sell its own output. We show that, under specific conditions, our results hold true under this scenario as well.

Essay III: Price Discrimination on Competing Platforms: We investigate price competition between two platforms when buyers assign different values to the interaction benefits on a platform. We introduce heterogeneous agents on the consumer side and analyse the platform's ability to successfully implement price discriminating strategies in the presence of competition from another platform. We compare results from two scenarios. The first is when one group of agents (sellers) are allowed to multi-home and the second is when they can only join a single platform. We find that in case of multi-homing, the platform can never charge more than the marginal cost to any consumer group. In the single-homing case, the strength of indirect network effects determines the side from which platform extracts a positive surplus.

सारांश

दो-तरफा प्लेटफॉर्म दो प्रकार के एजेंटों के बीच बातचीत की सुविधा प्रदान करते हैं। आज की शीर्ष पांच प्रौद्योगिकी कंपनियों में से चार दो-तरफा प्लेटफॉर्म हैं, जो उपयोगकर्ताओं के दो या अधिक विशिष्ट समूहों को जोड़ती हैं। Facebook, Amazon, Apple और Google विभिन्न उपयोगकर्ता समूहों को एक साथ लाने के लिए डिजिटल आधारभूत संरचना प्रदान करते हैं। मेरे शोध प्रबंध में निम्नलिखित तीन निबंध शामिल हैं जो दो तरफा मंच के साहित्य में योगदान करते हैं।

निबंध I: दो तरफा प्लेटफॉर्म पर विक्रेता प्रतिस्पर्धा

हम अध्ययन करते हैं कि विक्रेताओं के बीच नकारात्मक नेटवर्क प्रभाव एक प्लेटफॉर्म के मूल्य निर्णयों और उस पर खरीदारों और विक्रेताओं की संख्या को कैसे प्रभावित करता है। हम प्लेटफॉर्म पर विक्रेताओं के बीच प्रतिस्पर्धा को मॉडल करने के लिए सी.ई.एस यूटीलिटी फ़ंक्शन का उपयोग करते हैं। हालांकि, हम उत्पाद विविधता और विक्रेताओं के बीच स्थानापन्न वस्तुएँ का एक दूसरे पर प्रभाव को अलग करने के लिए फ़ंक्शन को संशोधित करते हैं। हम पाते हैं कि प्रतिस्पर्धा की तीव्रता में वृद्धि अनिवार्य रूप से एक विक्रेता के लिए, दो-तरफा मंच पर, हानिकारक नहीं है। वास्तव में, उत्पाद स्थानापन्न में वृद्धि जो मूल्य प्रतिस्पर्धा को बढ़ाती है, कीमत पर नीचे की ओर दबाव डालकर, और भी अधिक विक्रेताओं को और उपभोक्ताओं को मंच से जुड़ने के लिए आकर्षित करती है। प्रतिस्पर्धा में वृद्धि से प्लेटफॉर्म के मुनाफे में भी वृद्धि होती है।

निबंध II: डिलीवरी सेवा प्रदान करने वाले ई-कॉमर्स प्लेटफॉर्म का आर्थिक विश्लेषण

डिजिटल प्लेटफॉर्म कई प्रकार के व्यवसायों से जुड़ने के कारण अविश्वास जांच का विषय रहे हैं। हम एक दो चरण के खेल का मॉडल बनाते हैं, जहाँ प्लेटफॉर्म पहले चरण में अपनी डिलीवरी सेवा के लिए मूल्य निर्धारित करता है। प्लेटफॉर्म पर दो प्रकार के विक्रेता होते हैं। एक जो प्लेटफॉर्म की डिलीवरी सेवा का उपयोग करते हैं और अन्य जो स्वयं की डिलीवरी करते हैं। विक्रेता तय करते हैं कि दूसरे चरण में कितनी मात्रा में उत्पादन करना है। मॉडल जांच करता है कि विभिन्न विक्रेता प्लेटफॉर्म के डिलीवरी मूल्य और लाभ को कैसे प्रभावित करते हैं। हम पाते हैं कि प्लेटफॉर्म का लाभ उन विक्रेताओं की उत्पादन कीमत से नकारात्मक रूप से संबंधित है जो इसकी डिलीवरी सेवा खरीदते हैं और सकारात्मक रूप से उन विक्रेताओं की उत्पादन कीमत से संबंधित है जो अपनी डिलीवरी स्वयं करते हैं। हम इस विश्लेषण को एक ऐसे

मामले में आगे बढ़ाते हैं जहां प्लेटफॉर्म विक्रेताओं के साथ अपने स्वयं का आउटपुट भी बेचता है। हम दिखाते हैं कि, विशिष्ट परिस्थितियों में, हमारे परिणाम इस परिदृश्य में भी सही हैं।

निबंध III: प्लेटफॉर्म प्रतिस्पर्धा और मूल्य भेदभाव

हम दो प्लेटफॉर्मों के बीच प्रतिस्पर्धा का अध्ययन करते हैं, जब खरीदार एक प्लेटफॉर्म से के लाभों को अलग-अलग मूल्य प्रदान करते हैं। हम उपभोक्ता पक्ष पर दो प्रकार के एजेंटों को पेश करते हैं और दूसरे प्लेटफॉर्म से प्रतिस्पर्धा की उपस्थिति में मूल्य भेदभाव रणनीतियों को सफलतापूर्वक लागू करने के लिए मंच की क्षमता का विश्लेषण करते हैं। हम दो परिदृश्यों के परिणामों की तुलना करते हैं। पहला तब होता है जब विक्रेताओं को मल्टी-होम की अनुमति दी जाती है और दूसरा तब होता है जब वे केवल एक ही प्लेटफॉर्म से जुड़ सकते हैं। हम पाते हैं कि मल्टी-होमिंग के मामले में, प्लेटफॉर्म कभी भी किसी उपभोक्ता समूह से सीमांत लागत से अधिक शुल्क नहीं ले सकता है। सिंगल-होमिंग मामले में, अप्रत्यक्ष नेटवर्क प्रभावों की ताकत उस पक्ष को निर्धारित करती है जिससे प्लेटफॉर्म एक सकारात्मक अधिशेष निकालता है।

TABLE OF CONTENTS

Certificate	i
ACKNOWLEDGEMENTS	iii
ABSTRACT	v
List of Figures	xii
List of Tables	xiii
1 Introduction	1
1.1 Seller Competition on Two-sided Platforms	3
1.2 Fulfilled by Amazon	4
1.3 Price Discrimination on Competing Platforms	6
2 Seller Competition On Two-sided Platforms	9
2.1 Introduction	9
2.2 Related Literature	11
2.3 Nature of the Consumer Utility Function	12
2.4 Model	14

2.4.1	Timing of the Game	17
2.4.2	Seller Competition on a Monopoly Platform	17
2.5	Usage Pricing	22
2.5.1	Model	23
2.5.2	Second Stage	25
2.5.3	First Stage	25
2.6	Seller Competition on Competing Platforms	32
2.7	Conclusion	34
2.7.1	Limitations of the Study	35
2.8	Appendices	36
2.8.1	Seller Competition on a Monopoly Platform	36
2.8.2	Usage Pricing	38
2.8.3	Competing Platforms	41
3	Fulfilled by Amazon	45
3.1	Introduction	45
3.2	Related Literature	49
3.3	Baseline Model	50
3.3.1	Timing of the Game	52
3.3.2	Equilibrium	52
3.4	A General Framework	57
3.4.1	Numerical Simulations	61
3.5	Platform Competing with the Third-party Sellers	66

<i>TABLE OF CONTENTS</i>	ix
3.5.1 Numerical Simulations	69
3.6 Operational Mode that Maximises Total Quantity	71
3.7 Conclusion	74
3.7.1 Limitations of the Study	75
3.8 Appendices	76
3.8.1 A General Framework	76
3.8.2 Numerical Simulations	83
3.8.3 Platform Competing with Third-party Sellers	86
4 Price Discrimination on Competing Platforms	91
4.1 Introduction	91
4.2 Related Literature	93
4.3 Model	95
4.3.1 Buyers	95
4.3.2 Sellers	97
4.3.3 Monopoly Platform	98
4.4 Competing Platforms	99
4.4.1 Buyers single home and sellers multi-home	100
4.4.2 When both buyers and sellers single home	109
4.5 Conclusion	111
4.5.1 Limitations of the Study	112
5 Conclusion	113

Curriculum Vitae

119

LIST OF FIGURES

2.1	Number of sellers and profit of the platform for different values of ρ	21
2.2	Change in optimal number of sellers due to change in ρ , when $\theta = 0$ and platform charges a usage fee to the seller	28
2.3	Change in optimal number of buyers due to change in ρ , when $\theta = 0$ and platform charges a usage fee to the seller	28
2.4	Change in optimal profit due to change in ρ , when $\theta = 0$ and platform charges usage fee to the seller	29
3.1	An E-Commerce Platform	47
3.2	Change in Optimal profit of Platform due to change in average cost of FBA sellers.	62
3.3	Shifts in Optimal profit curve of the Platform due to change in different parameters.	63
3.4	Change in Optimal profit of Platform due to change in average cost of non-FBA sellers	64
3.5	Shifts in Optimal profit Curve of the Platform due to change in different parameters.	65
3.6	Change in the optimal profit curve due to change in c_k	70
3.7	Change in the optimal profit curve due to change in c_n	71

3.8	Change in Platform's optimal profit due to change in the number of FBA sellers k	84
3.9	Change in Platform's optimal profit due to change in the number of non-FBA sellers n	85

LIST OF TABLES

2.1	Optimal number of sellers for different values of ρ under subscription pricing.	20
2.2	Optimal Outcomes for different values of ρ when $y = 100$ and $c = 5$	27
3.1	Symbols and definitions	59
3.2	Comparing Equilibrium Outcomes across two modes of Operation for the Platform	72
3.3	Equilibrium Quantity when FBA sellers sell zero output	74