

DOCTORAL PROGRAMME

ESSAYS ON INTERNET ECONOMY

By

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“Behind the parents stands the school, and behind the teacher the home.”

– A.P.J. Abdul Kalam

To my dear teachers and parents

Abstract

Internet is a wider network of computer networks that allows various stakeholders such as firms, educational institutions, governments etc., to connect through their devices and communicate with one another. It is through these computer networks that we are able to organize our daily lives be it work from home, ordering groceries to watching our favorite shows online. Internet economy is based on the digital technologies, and it covers economic, social and cultural activities that occur on the Internet between different stakeholders. [Page et al. \[2016\]](#) present the market structure and economic drivers of Internet economy through the five segments of Internet value chain that covers content rights, online services, enabling technology and services, connectivity, and user interface segments. We focus on some of these segments of Internet value chain such as online services, enabling technology and services and connectivity, with focus on problems of key players such as Content providers (CPs) and Internet service providers (ISPs). Telecommunication networks form the backbone of Internet infrastructure and comprises of components such as international networks, transit ISPs and access ISPs. Our focus is on access ISPs which provide different local network services to the end-users to access or use Internet. CPs in general provide application or content in the form text, music or video which end-users access through the servers.

With the on-demand content market evolving and with intense competition, one challenge faced by the CPs is to decide on a revenue model with the most prominent ones being subscription-based revenue model, advertisement-based revenue model and hybrid where part of the content catalogue is offered for free and rest of it is offered for a premium. Additionally, the strategic interaction between ISP and CP plays a significant role in revenue and pricing decisions in the digital content supply chain, which involves the processes of digital content creation such as movies and short videos, content aggregation, and content distribution by a CP; Internet services by ISP; and content consumption by end-users. This motivates us to ask the following research questions: Which revenue model should the CPs go for considering the presence of other entities in the content supply chain such as the ISP? When should the CPs go for subscription-based revenue

model, advertising-based revenue model, or a hybrid revenue model? In chapter 2, we study the impact of three types of revenue models of a CP – *subscription, advertising, and hybrid models* on the pricing strategies of an ISP under two different market structures – *monopoly and duopoly*. We analyze the interplay of difference in quality of experience (QoE) between CPs on their pricing decisions and the impact of QoE, specifically, network enhancement and sensitivity to QoE on ISP’s pricing decisions. In the monopoly market, we find that an ISP prefers a market with particular revenue model of CP based on its investment in QoE and the fit cost parameter. On the other hand, the CP performs well with hybrid or subscription-based models with increase in fit cost indicating that premium content is a profitable option. In the duopoly market, we analyze the performance of CP with respect to the three revenue models. With competition between subscription-based and advertisement-based CPs, we find that as sensitivity to QoE increases above a threshold and when the QoE of the advertising-based CP is restricted, subscription-based CP earns better. Further, we also find the threshold conditions for ISP in the three duopoly market scenarios and study its preferences towards the network-enhanced CPs.

Earlier telecom companies have grown traditionally on voice and data services. With the rapidly changing consumption patterns and the advent of technology, the ISPs are looking for other means to grow their revenues, while at the same time owning a profitable mobile delivery channel. Digital advertising appears to be a lucrative option to the ISPs, which is a part of enabling technology and services segment of the Internet value chain. Therefore, ISPs are gearing up to play an additional role of ad network provider and facilitate the transactions between the advertisers and the CP, by gathering a diversified portfolio of ad inventory from advertisers and helping the CP in filling their ad-spaces. With this context, in chapter 3 we study the pricing, quality and revenue sharing decisions of ISP and CP under competition and bargaining scenarios. We identify the conditions under which ISP functions as an ad network provider and the conditions under which the CP follows different revenue models. Our key results show that, in the case where ISP shares its ad revenue with CP, costliness to quality influences the performance of CP and ISP. We also find that, under certain conditions, the additional role as an ‘ad network provider’ is beneficial to ISP. In the bargaining scenario, we derive the share of revenue that ISP and CP bargain for and study the impact of sensitivity to ads on their profits. Further, we extend our model to a duopoly ad network market by including a third-party ad network provider. Our paper contributes to the literature on revenue management and Internet value chain by incorporating an alternative way in which ISPs can diversify

their business (i.e. by operating as an ad network provider), and by studying the impact of this alternative business model on the revenue decisions of the stakeholders.

With a surge in smartphone adoption and internet usage, ISPs and CPs are making every possible effort to attract more end-users, and finding ways to diversify their businesses. In chapter 4, we study telecom offerings and data pricing plans offered by ISPs to the end-users, namely *sponsored data* and *free subscriptions*. We consider a scenario when an ISP, in addition to providing internet services to its end-users, also acts as a *hosting network operator* (HNO) for a CP. A CP using the services of an HNO, in addition to offering digital contents to its users, can play the role of a *mobile virtual network operator* (MVNO) and compete with the ISP for the internet data users. Using game theory, we model and analyze the strategic interactions between ISPs and CPs considering that they could also act as network service providers (ISP as HNO and CP as MVNO) in addition to providing internet services and offering digital contents respectively. We derive the equilibrium pricing and sponsored data related decisions, and find the threshold conditions under which a CP sponsors a positive amount of data. We identify the conditions under which a CP and an ISP prefer one telecom offering over the other. Further, we derive the threshold conditions under which an ISP and a CP are better-off in their network service provider roles (HNO and MVNO respectively). Lastly, we derive conditions under which ISP and CP compete or cooperate with each other. This paper will guide the concerned stakeholders in understanding the dynamics of sponsored data and free subscription offerings under HNO-MVNO setting.